Charles University in Prague

Faculty of Social Sciences

Institute of Economic Studies

MASTER'S THESIS

Education and Crime:
A Panel Data Analysis of the Czech Republic

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Declaration of Authorship

The author hereby declares that she compiled this thesis independently, using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, May 11, 2015

Signature

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Abstract

This thesis focuses on the relationship between crime and education, as well as macroeconomic and demographic factors such as police efficiency, GDP per capita, employment rate, population density, age and sexual composition of the society.

We use the data of fourteen regions of the Czech Republic from 2000 to 2012. First, we apply the fixed-effect model in the data analysis, and further we use GMM for the estimation of new dynamic panel dataset. In addition, taking the possible time effects into account, we also add the time dummies in both regression models.

Our finding finds the unexpectedly positive effects of secondary education with A-level exam, GDP per capita and the proportion of population aged 30-59 years old on most of criminal offences. On the other hand, the male ratio in population and the clearance rate are found to influence crimes negatively. Higher education and employment rate are also found to be related negatively with economic crimes.

JEL Classification	A14, E69, I21, I23, I25, I29, J19, R19
Keywords	education, crime, employment, GDP, gender ratio, age, the Czech Republic, panel data, fixed-effect, GMM
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Acronyms

CR	Czech Republic
Czech Police	Police of the Czech Republic
CZK	Czech koruna
CZSO	Czech Statistical Office
EU	European Union
GCE	General Certificate of Education
GDP	Gross domestic product
GMM	Generalized method of moments
HAC	Heteroskedasticity autocorrelation consistent
ISCED	International Standard Classification of Education
OECD	The Organization for Economic Co-operation and Development
MEYS	Ministry of Education, Youth and Sports
MoI	Ministry of the Interior
MoJ	Ministry of Justice
MoLSA	Ministry of Labour and Social Affairs
NUTS	Nomenclature of Territorial Units for Statistics / Nomenclature of Units for Territorial Statistics
US	United States
VET	Vocational education and training

Master's Thesis Proposal

Author:	Hsin-I Lin
Supervisor:	Mgr. Pavla Břízová
Defense Planned:	June 2015

Proposed Topic:

Education and Crime: A Panel Data Analysis of the Czech Republic

Motivation:

There was an important change in Czech education system in the end of the 20th century. The private elementary education have been in existence since 1990, and the tertiary/university education has also been allowed to be provided privately since 1999. This deregulation of educational institutes can be considered as a big progress in Czech education development.

According to the statistics from Czech Statistical Office (Český statistický úřad, ČSÚ) and the Ministry of Education, Youth and Sports (Ministerstvo školství, mládeže a tělovýchovy, MŠMT), the number of higher education institutes (vysokoškolské studium) has rapidly increased, from merely 13 in 1999/2000 to 32 in 2013/2014. Apart from it, there is one fifth of population with higher education degree in 2013, two times higher than the rate in 1993. From the statistics, it is not difficult to see how fast the educational development is in the Czech Republic.

As the ratio of high-education attainment has been rising in recent years, people started to pay more attention to its quality and discuss the influence on the society. In this thesis, I am going to focus mainly on the effect of educational levels on crime rates in the Czech Republic, with the consideration of economic and demographic information. The data of thirteen Czech regions from 2005 to 2012 will be collected for the analysis. I plan to use fixed effect model/random effect model, and then generalized method of moments (GMM) to verify the assumption that, within an area, the higher educational attainment of its residents, better economic situation and lower male ratio to population will lead to lower crime rates.

Hypotheses:

- Hypothesis #1: Higher educational attainment leads to lower crime rates.
- Hypothesis #2: Better economy (higher income, higher employment rate) leads to lower crime rates.

- Hypothesis #3: Males tend to commit more crimes than females.

Methodology:

In this thesis I am going to use fixed effect model/random effect model and GMM to check the relationship between educational attainment and crime rates in different Czech regions. In addition, I add other economic and demographic variables such as gender, age, employment rate and income into the regression to see their influence on crimes.

The data is mainly collected from the Czech Statistical Office, among thirteen regions of the Czech Republic in the period of 2005-2012. The regional data contains yearly information of educational attainment ratio, crime rates, sex and age ratio, average personal income and employment rate. With the data, I expect to observe the relationship between crime rates and educational attainment, as well as macroeconomic and demographic factors.

Since the data I use for the analysis is panel data, simply using OLS may cause ignorance of individual and time difference, and then lead to coefficient inconsistency. In order to avoid this problem, it is necessary to apply either fixed effect model or random effect model (Chen, 2008). And based on the result of Hausman test, the model can be chosen to fit our panel data best.

However, there is possible criminal inertia and the joint endogeneity problem among variables. Both can make coefficients inconsistent, and thereby the result may be unreliable (Lio & Lu, 2011). Therefore, it is important to further consider this dynamic phenomenon. It can be achieved by adding the lag-dependent variable, in other words, the GMM estimator, into the regressions, which is considered as an ideal method for the panel data analysis (Fajnzylber, Lederman & Loayza, 2002) (Buonanno & Leonida, 2009).

Expected Contribution:

By the analysis I want to verify if there is a positive effect of education on reduction of crime, and also check the relationships between chosen economic and demographic variables and crime rates. Besides, I expect to provide more detailed explanation of the crime occurrence, which is hopefully helpful for further social policy formulation and improvement. For example, if the inverse relationship between crime rates and education level is proved, part of government budget for law enforcement can be used for educational purposes. In addition, it can be a base for further research into this topic and possibly bring about a new crime-prevention approach focusing more on offenders' education levels.

Outline:

- Introduction: I will make a short introduction of education system, crime rates and the possible relationship of both in the Czech Republic, and explain why I chose this topic.

- Literature review: I will give a brief overview of related research articles, and their methodology and findings.
- Data: I will describe the data sources, as well as the definition, research period and calculation.
- Methodology: I will describe the characteristics of panel data, further explain why I use fixed effect model/random effect model and GMM for the data analysis.
- Result: Based on the regression results, I will discuss the validity of hypotheses.
- Conclusion: I will summarize my findings, and provide the implications to current Czech education system for future improvement and related research.

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Author

Supervisor

Chapter 1 Introduction

"He who opens a school door, closes a prison." - Victor Hugo

There was an important change in Czech education system in the end of the 20th century; the private elementary education has been in existence since 1990, and the tertiary/university education (*"vysokoškolské studium"*) has also been allowed to be provided privately since 1999.[1] This deregulation of educational institutes can be considered as a big progress in Czech education development.

Take the higher education in the Czech Republic as an example: according to the statistics from the Czech Statistical Office (*"Český statistický úřad",* CZSO) and the Ministry of Education, Youth and Sports (*"Ministerstvo školství, mládeže a tělovýchovy",* MEYS), the number of higher education institutes (*"vysoké školy"*) has increased rapidly, from merely 23 in 1999/2000 to 71 in 2013/2014, of which the private institutes account for 60%. Figure 3 and 4 illustrate this increasing trend of education institutes. Apart from it, there was 16.7% of population with tertiary education degree in 2013, which was two times higher than the data of 7.8% in 1993. At the same time, the ratio of people with merely basic, pre-primary or even with no education decreased greatly from 27.6% in 1993 to 14.9% by the end of 2013. The change in educational attainment during last 20 years can be

[1] The Ministry of Education, Youth and Sports (2012)

found in Figure 5. From these statistics, it is not difficult to see how fast the educational development is in the Czech Republic within these years.

As the number of education institutes and the educational attainment ratio have been significantly rising in recent years, people start to pay more attention to the quality of education and discuss its influence on the society. One of the main issues is the crime. Economic theory implies that education can help reduce most types of criminal offences (Lochner, 2007); on the contrary, Chen and Li (2011) also mentioned the hypotheses that higher level of education does not have a positive influence on crime reduction, but increases the economic crimes instead.

The objective of this thesis is to observe the effect of educational levels on crime rates in the Czech Republic, with the consideration of economic and demographic information. The annual data of fourteen Czech regions (*"kraje"*) based on NUTS 3 classification from 2000 to 2012 are collected for the analysis.[2] According to the researches by Fajnzylber, Lederman and Loayza (2002), Buonanno and Leonida (2009) and Lio and Lu (2011), we apply fixed effect model with consideration of crime dynamics as well as various regional characteristics to verify the assumption that, within an area, the higher educational attainment of its residents and better economic situation lead to lower crime rates. Moreover, we add demographic factors to check if males are more likely to be offenders than females, and if cities are hotbeds of crime as Blackmore, F.L.E. (2003) and Chen

[2] NUTS classification was first introduced by Eurostat, providing EU authorities a standard unified structure of territorial units. There are six NUTS levels: NUTS 0, NUTS 1, NUTS 2, NUTS 3, NUTS 4 and NUTS 5, the definition of which is characterized by the territorial size and population. In the thesis we use NUTS 3 as the estimation units, which are so-called "*kraje"*: Hlavní město Praha, Jihočeský kraj, Jihomoravský kraj, Karlovarský kraj, Kraj Vysočina, Královéhradecký kraj, Liberecký kraj, Moravskoslezský kraj, Olomoucký kraj, Pardubický kraj, Plzeňský kraj, Středočeský kraj, Ústecký kraj and Zlínský kraj. (The Czech Statistical Office, 2014)

(2008) found in the case of South Africa and Taiwan. Afterwards, we further look into those factors' influence on different types of crime.

The thesis is structured as follows: next chapter provides a background knowledge of education and crime condition, as well as the statistical data in the Czech Republic. A review of recent literature about the relationship between education, crime and other possible factors is presented in Chapter 3. Chapter 4 is the hypotheses statement based on the summary of literature review. The data and empirical model we expect to apply in this thesis, with its methodological background, are all introduced in Chapter 5, followed by the empirical result in Chapter 6. The findings from the analysis is concluded in the last chapter.

Chapter 2 Education and Crime

This chapter provides short introduction of education system and its development in the Czech Republic, as well as crime environment and selected statistics.

2.1 Education in the Czech Republic

2.1.1 Background information

The Czech Republic has had a long history of education development. As early as 1398, Charles IV established a university in Prague, the first higher education institution in the central Europe. Later in the 17th century, Jan Amos Komenský, the Czech philosopher, pedagogue and theologist, also known as the founder of modern education, brought out the new idea and method of education. Another big step in education happened in 1774, when compulsory education system was firstly instituted by Empress Maria Theresa in the Habsburg Monarchy.[3] All these historical milestones helped to shape the current education in the Czech Republic.

Afterwards in the 20th century, the Czech Republic went through the German occupation and the socialism. Inevitably, there were several changes in its education system. After the Velvet Revolution ("*sametová revoluce*") in 1989, finally, the democracy again came back to the Czech land and many educational reforms were introduced in the end of the 20th century. School autonomy and

[3] The Ministry of Education, Youth and Sports (2012)

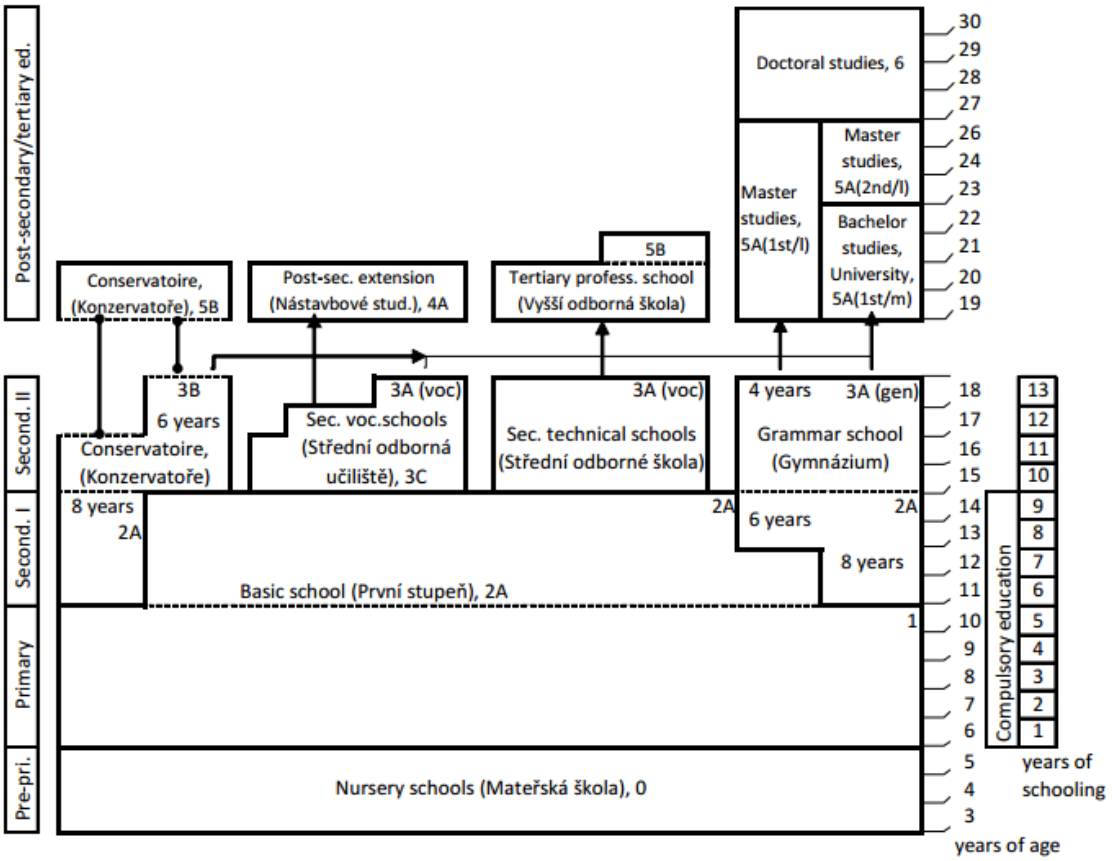
private educational institutions permission were regarded as the most important changes in the Czech education system. The private elementary and secondary education have been in existence since 1990, and the tertiary/university education (*"vysokoškolské studium"*) has also been allowed to be provided privately a little bit later since 1999. On the other hand, since the beginning of 2003, all educational institutes have been granted the legal status; school officials should bear full responsibility for the education quality, financial management and the appointment and dismissal of teachers. [4] These deregulations on educational institutes are considered as a big progress in Czech education development.

Nowadays, according to the report from the Ministry of Education, Youth and Sports (*"Ministerstvo školství, mládeže a tělovýchovy",* MEYS), there are five types of education institutes in the Czech education system, respectively: pre-primary/nursery schools, primary schools (primary and lower secondary education), secondary schools (upper secondary education, including vocational education and training, VET), conservatories and post-secondary colleges. Under the system, the compulsory education includes primary and lower secondary education, and it usually lasts for nine years, from the age of 6 to 15. During the first five years students study in a comprehensive basic school (primary education), afterwards they can choose to continue in the basic school, or proceed to either gymnasiums (*"gymnasium"*) or eight-year conservatoire (secondary education). Figure 1 provides the detailed information of current education system in the Czech Republic with categories of educational institutes and

[4] Straková (2008) and the Ministry of Education, Youth and Sports (2012)

schooling years. It is also worth noting that, in addition to the local educational types, the ISCED 97 classification[5] is also adopted in the Czech Republic for the EU statistical usage. This classification can be seen in Figure 1 as well. The conversion between these two classification systems will be introduced again in the data description in Chapter 5.

Figure 1 - The Czech education system



Source: Straková, J. (2008), pp. 221

[5] ISCED is educational classification issued by UNESCO in November 1997, with seven levels in total (0-6). This classification is also applied in the statistical systems of the CZSO and the Ministry of Justice (*"Ministerstvo spravedlnosti ČR"*, MoJ). (The Czech Statistical Office, 2014b)

2.1.2 Statistics

After brief background introduction of the Czech education system, we are going to take a further look at education-related statistics.

Education Expenditure

According to the statistical data from the CZSO and the MEYS, in spite of the reduction occurring in 2008 (possibly because of economy recession during the financial crisis), the government expenditure on education in the Czech Republic had increased by 0.5 percentage points of GDP in the past thirteen years, rising from 97,935.53 million CZK in 2001 to 172,805.17 million CZK by the end of 2013. At the individual level, the government spent 16,438.2 CZK on each citizen in 2013, which was approximately 70% higher than the level of 9,578.8 CZK in 2001. From the increasing proportion of national education expenditure in the last 13 years, we can get the implication that the importance of education to the public is also rising gradually in the Czech Republic. Table 1 lists the public expenditure on education in the time period of 2001-2013.

We further make the international comparison of the education expenditure as of GDP. We choose the statistical data of the EU (the average of 27 member countries[6]), Denmark (with the highest proportion of education expenditure in GDP within the EU), the United States and Taiwan from 2001 till 2011. The change is illustrated in Figure 2. The proportion of average education expenditure as of total GDP in the EU had been rising continually since 2001. The Czech Republic

[6] Here we use the EU data excluding Croatia. We use the data in the period of 2001 to 2011, and Croatia became the member of the EU later in 2013. Therefore, it was not regarded as the object in the chosen education expenditure statistics.

and Denmark showed the similar trend, but with a decline in the mid-2000s perhaps due to the economic crisis. In contrast with the increase, the US and Taiwan had slightly lower expenditure on education in 2011 in comparison of the level in 2001. Moreover, Figure 2 also discloses an important information that, even though the expenditures seem gradually increasing in the Czech Republic as mentioned in the previous section, it still has quite low ratios of education expenditure in GDP at the international level (among other chosen countries), even 50% lower than Denmark. From the statistics, the Czech authorities should also realize that relatively low funding for education can be hidden worries of the future education development in the Czech Republic.

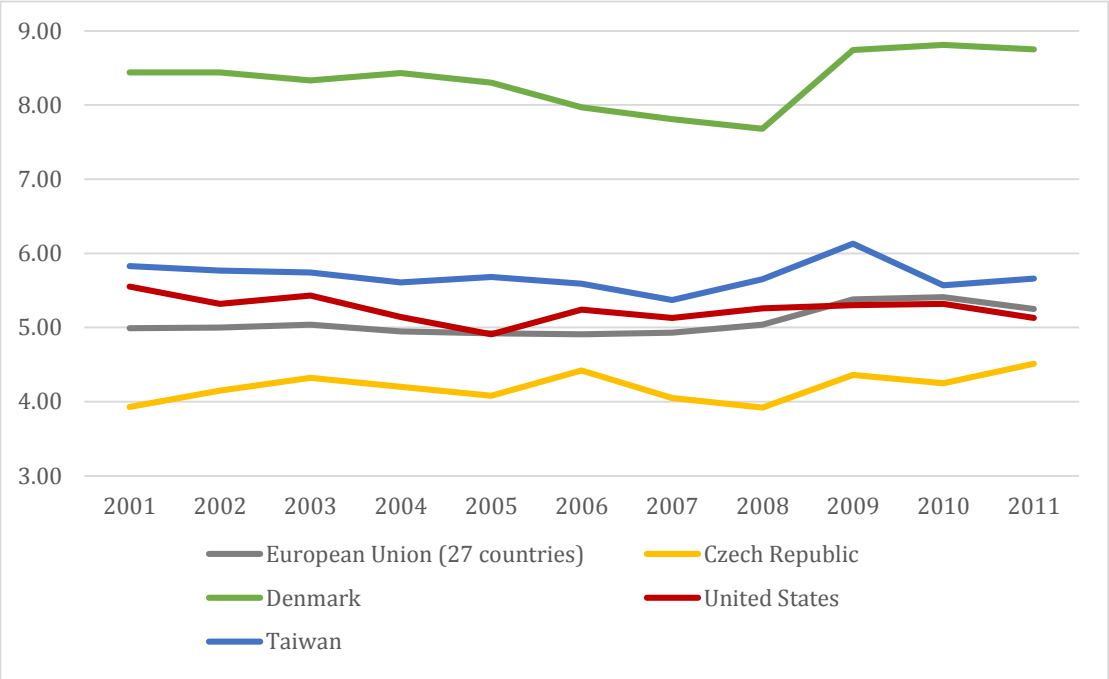
Table 1 - Education expenditure in the Czech Republic 2001-2013

Year	Total Education Expenditure (% of GDP*)	Total Education Expenditure (mil. CZK)	Education Expenditure per capita (CZK)
2001	4.0	97,935.53	9,578.80
2002	4.2	108,531.30	10,639.52
2003	4.3	115,848.65	11,355.87
2004	4.2	123,038.47	12,054.41
2005	4.2	130,316.16	12,733.53
2006	4.3	142,830.94	13,912.13
2007	4.2	152,987.77	14,820.53
2008	3.9	151,003.00	14,478.18
2009	4.4	163,943.01	15,626.28
2010	4.3	162,965.06	15,495.03
2011	4.5	173,721.97	16,550.20
2012	4.5	171,369.87	16,306.52
2013	4.4	172,805.17	16,438.19

Note: *It is nominal GDP.

Data source: the Ministry of Education, Youth and Sports (2014)

Figure 2 – Education expenditure comparison (% of GDP*) 2001-2011



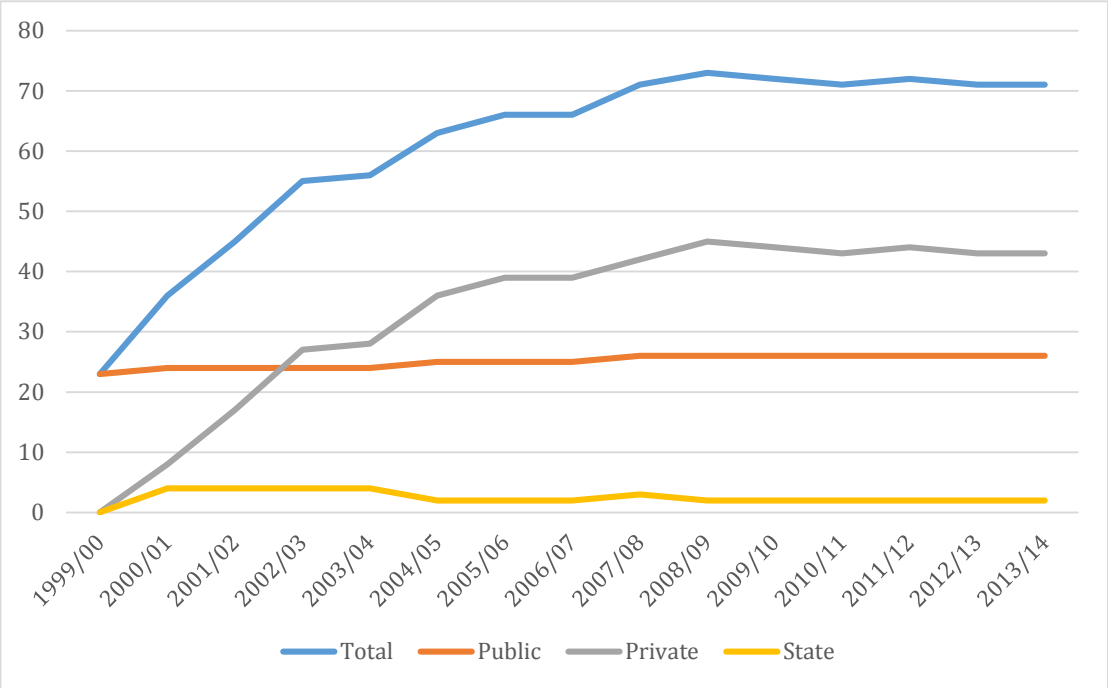
Note: *It is nominal GDP.

Data source: Eurostat (2014a) and National Statistics, R.O.C. (Taiwan) (2014)

Education Provision

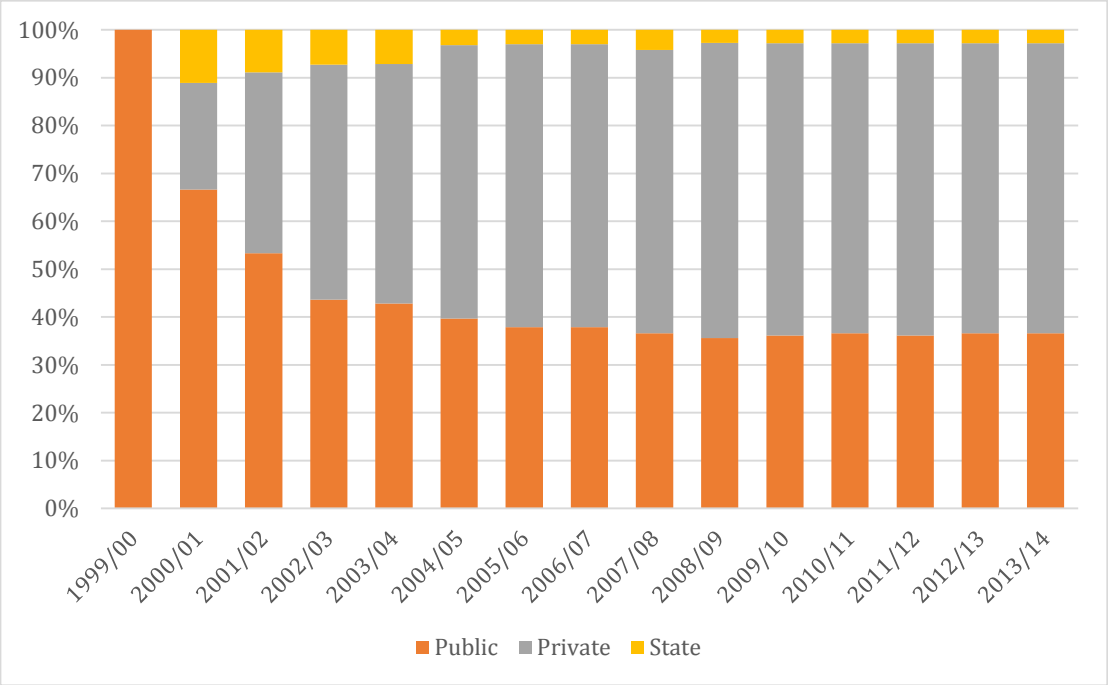
Apart from the rising expenditure on education, there was also a continuous increase in the education provision over the years. Take the tertiary education in the Czech Republic as an example, after the deregulation on private-owned schools in 1999, the number of higher education institutes had increased rapidly, from merely 23 in 1999/2000 rising to 71 in 2013/2014. Figure 3 depicts the increases in institutes. The proportion of each type of higher education institutes are illustrated in Figure 4.One thing is worthy of attention that, among the newly established institutes, private ones provide the greatest contribution to this fast growth. By the end of 2013, there were 43 private higher education institutes in the Czech Republic, which accounted for 60% of total amount. By contrast, there

Figure 3 - Number of higher education institutes 1999/00-2013/14



Data source: the Czech Statistical Office (2014a)

Figure 4 - Proportion of higher education institutes 1999/00-2013/14



Data source: the Czech Statistical Office (2014a)

was only a slight increase in the number of public schools, and merely two state-owned institutes[7] still existed in 2013.

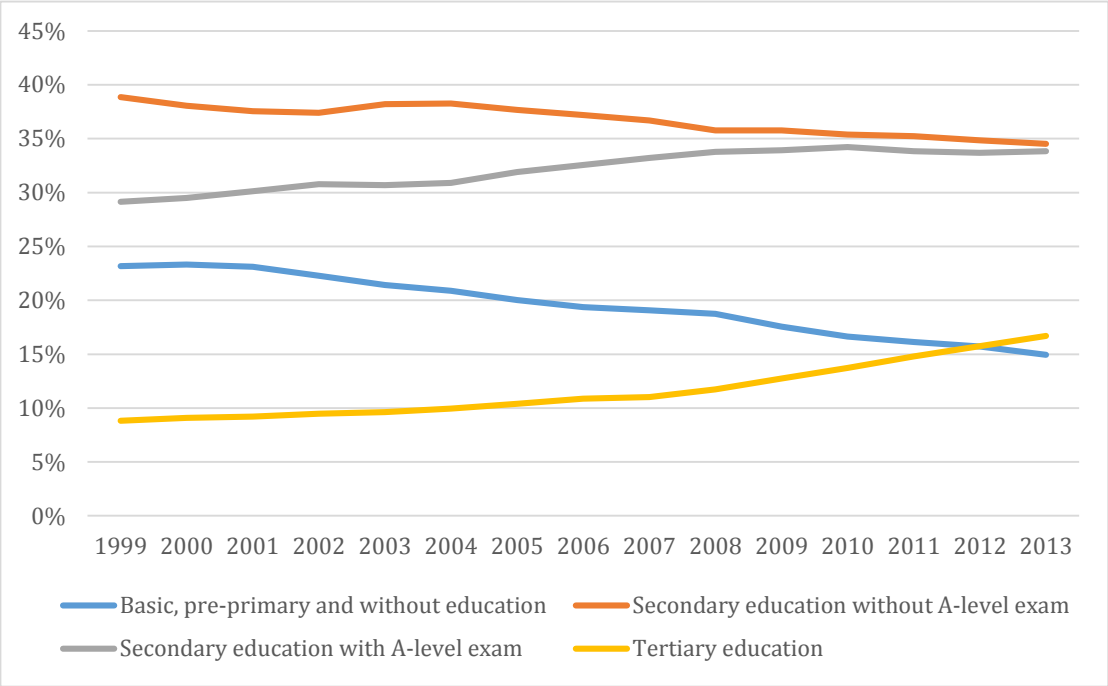
Educational Attainment Rate

Thanks to the fast education development, people can have more opportunities to get higher education than before. Figure 5 shows the changes in educational attainment from 1999 to 2013. Both attainment rates of secondary education with A-level exam[8] and tertiary education were rising gradually over time, while considerable declines in the remaining types of educational attainment. By the end of 2013, there was 16.7% of population attaining higher education degree, which was almost two times higher than the data of 8.8% in 1999. Moreover, the percentage of population with only basic, pre-primary or even with no education dropped greatly, from 23.2% in 1999 to 14.9% in 2013. These statistics may imply the success of the Czech education expansion since 1990s, and the Czech Republic is moving toward a highly educated society.

[7] Only the University of Defense and the Police Academy still remain state institutions, which are fully stated-funded and owned respectively by the Ministry of Defense and the Ministry of Interior. The public institutions to the contrary are state-subsidized. (The Ministry of Education, Youth and Sports, 2012)

[8] Also known as general certificate of education (GCE), "*maturita"* or "'*maturitní zkouška".* It is the minimum entrance qualification for all forms of tertiary education. (Straková, 2008) In the official statistical document from the CZSO the term A-level exam is adopted. Therefore, we use the same term throughout the thesis.

Figure 5 - Educational attainment rate 1999-2013



Data source: the Czech Statistical Office (2014b)

2.1.3 Regional Statistics

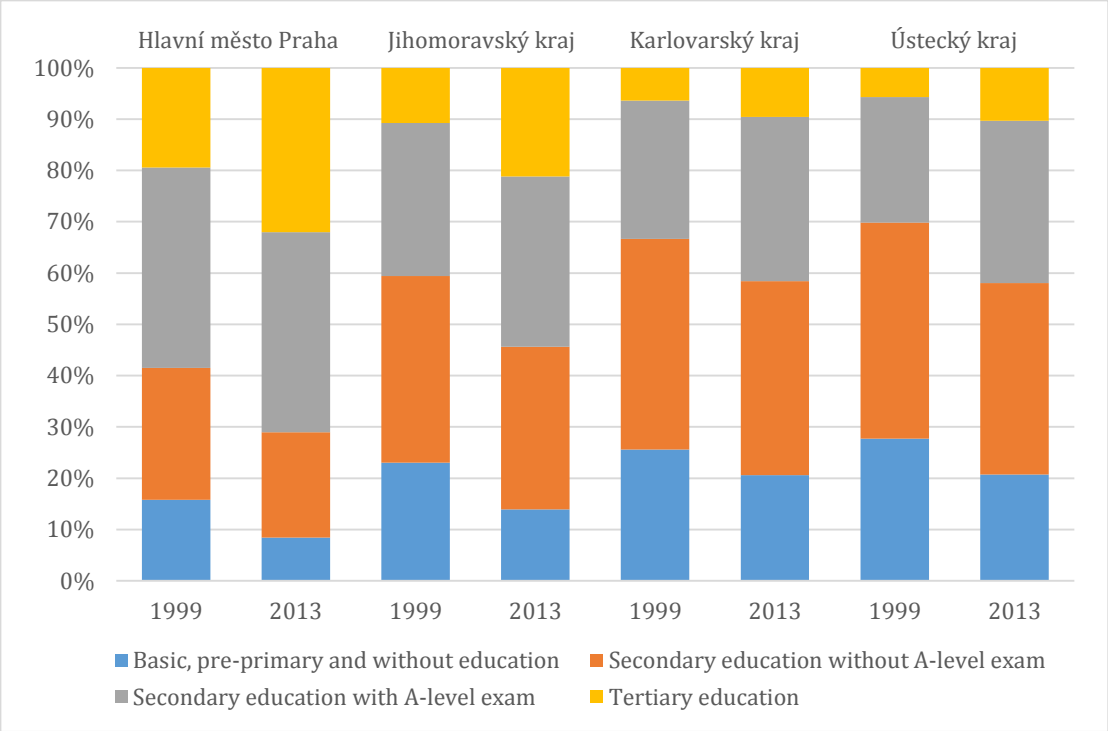
Educational Attainment Rate

Nevertheless, if we change the scope of education expansion from the whole country to regions, there are huge differences between each other. We make a simple comparison between four regions: two with highest tertiary educational attainment rates (Hlavní město Praha and Jihomoravský kraj), and two regions with lowest rates (Karlovarský kraj and Ústecký kraj) in 1999 and 2013.

Figure 6 shows this regional difference: the education expansion seemed to be more concentrated in the regions with initially high educational attainment rates. There was 32% of population with tertiary education in Prague in 2013, which was not only 12.7 percentage points higher than in 1999, but also almost

two times higher than the average of the whole country in the same year.[9] On the other hand, there were only 9.6% and 10.3% of population obtaining higher education degree in Karlovarský kraj and Ústecký kraj respectively in the end of 2013, with merely 3.2 and 4.7 percentage points increases in the last 15 years. What is worse, at the same time there was up to one fifth of population being uneducated or attaining basic education only in these regions. In comparison with Prague's data of 8.46% in the same category, it is not difficult to see how poorly Karlovarský kraj and Ústecký kraj performed in education.

Figure 6 - Regional educational attainment rate in 1999 and 2013



Data source: the Czech Statistical Office (2001-2013)

[9] According to the labor data from the Czech Statistical Office (2001-2013), the average attainment rate of tertiary education in the CR was roughly 16.7% in 2013. The statistical data can be found in Figure 5 as well.

The regional statistics are in accordance with the findings from Illner and Andrle (1994) and Chromý and Janů (2003): owing to the complicated historical experiences during the 1930s-1940s and subsequently a high ethnic heterogeneity, there are comparatively lower regional identity rates, educational levels of population and development in the north-Bohemian areas, such as Karlovarský kraj, Liberecký kraj and Ústecký kraj, than other regions. From the big differences in regional statistical data, it should be noticed that, even though the education system has been successfully improved and seems to work well currently, the problem of uneven regional development still remains an important task for the Czech government to deal with.

2.2 Crime in the Czech Republic

In this section we are going to take a look at the crime development in the Czech Republic with the crime records provided by the Ministry of the Interior of the Czech Republic (*"Ministerstvo vnitra České republiky",* MoI).

2.2.1 Statistics

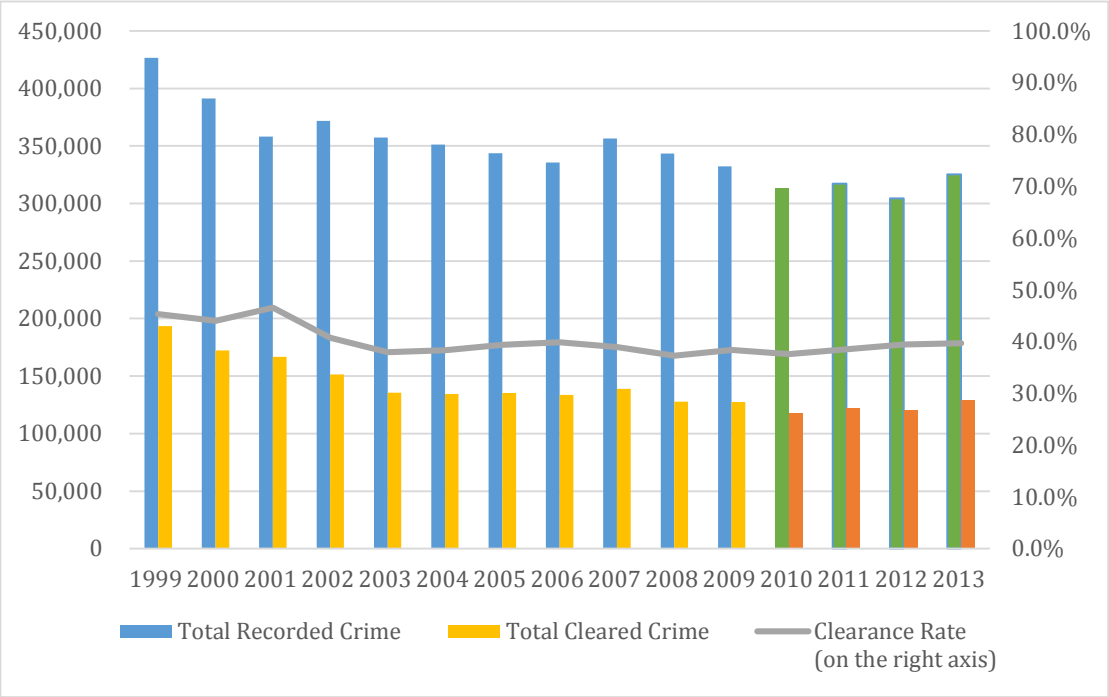
Recorded Crimes

Figure 7 illustrates the recorded criminal cases in the Czech Republic in the period of 1999-2013. There had been a decline with slight fluctuation in the total number of crimes since 1999, from the amount of 426,626 criminal offences in 1999 to 325,336 in 2013[10]. However, in spite of the reduction in total crimes, the overall

[10] On January 01, 2010 the new criminal code came into effect and new crime categories were introduced. Even though the data before and after the new measurement is not fully comparable, taking the majority types of crime and their importance into account, the change in new criminal codes does not affect the picture of the selected criminal categories greatly. Therefore, in this thesis

crime clearance rates decreased with time as well. In comparison with the data between 1999 and 2001, the clearance rates afterwards were around 6 percentage points lower, remaining at the level of 39%.

Figure 7 - Recorded crimes in the Czech Republic 1999-2013



Note: In respond to newly introduced crime categories on January 01, 2010, we use different colors to distinguish the change.

Data source: the Ministry of Interior of the Czech Republic (2004-2013)

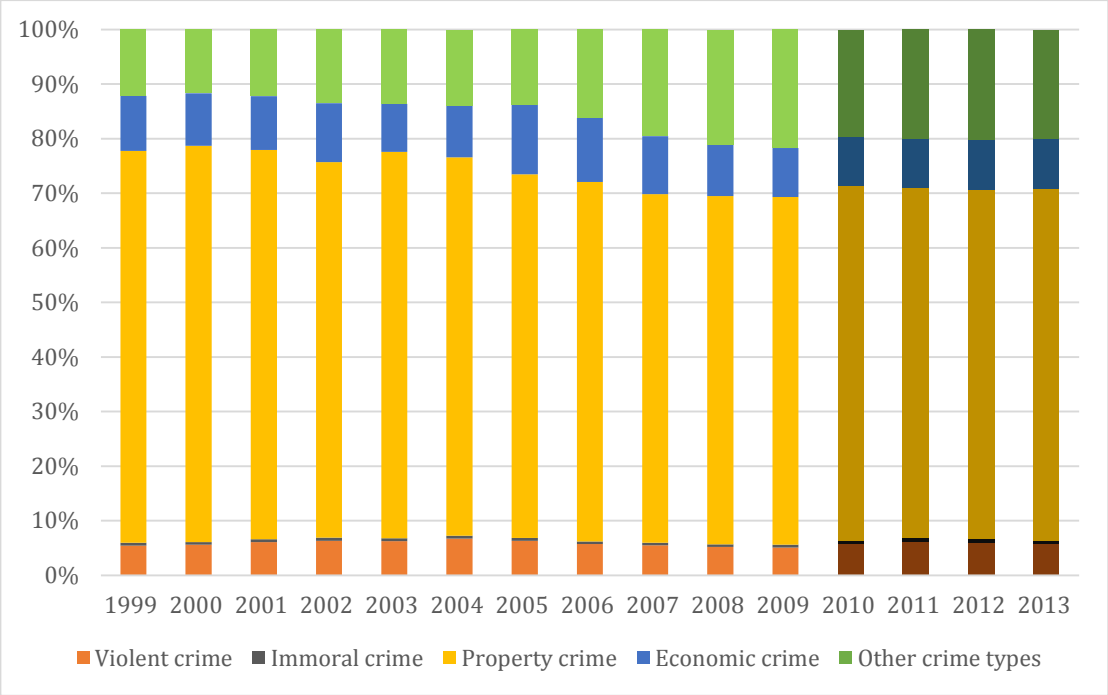
Additionally, Figure 8 shows the composition of recorded criminal activities[11] each year as supplementary information of Figure 7. We can notice that the crime against property was the main criminal type in the Czech Republic, but its proportion continued to decline since 1999, from 71.8% of total crime to 64.3% in 2013. By comparison, violent crime accounted for 5.5% of total criminal offences

we still put these two dataset together for analysis, and at the same time we add the time variable into the regression to capture the influence from this policy change.

[11] For more detailed information of crime types, please check Table 7 in the chapter 5.1.3.

stably over the time period of 1999-2013. Similarly, economic and immoral crimes also remain at the level of 10% and 0.6% respectively out of total amount of crime during the past 15 years.

Figure 8 – Composition of recorded crimes in the Czech Republic 1999-2013



Note: In respond to newly introduced crime categories on January 01, 2010, we use different colors to distinguish the change.

Data source: the Ministry of Interior of the Czech Republic (2004-2013) and its private-use data

When analyzing the crime statistics, it is necessary to think about the reliability of these numbers. Lin (2007) found the opposite result when using different dataset (the police crime data and victimization data) in the international crime analysis. He mentioned that the trust in police can change people's willingness of reporting the crimes to the police, and further affect the reliability of data. Likewise, Blackmore (2003) in his analysis of South Africa indicated the reason of data incompletion perhaps is because victims have low incentive to report unpleasant offences such as assaulting. All these circumstances can cause

the problem of high number of unregistered crimes, which is so-called the dark figure of crime.

As Wang (2000) and Zhou and Cao (2007) mentioned, this dark figure problem lets the authorities unable to know the actual situation of domestic crime, and then causes ineffective use of police and judicial resources. Inevitably, it can lead to estimation errors in our crime analysis as well. Despite the imperfectness of official crime data, nevertheless, its long-term and wide range of criminal records still have advantage in crime analysis. Besides, in some types of criminal offences such as intentional homicide there are usually much fewer dark figures in data. Therefore, we decide to use the official crime data to capture the general knowledge of criminal activities in the Czech Republic. But at the same time, we still need to be aware of the potential biases caused by unregistered crimes.

Recorded Damages

The financial loss generated by crime is another important issue. Table 2 shows total recorded and recovered damages from criminal activities in the Czech Republic during the period of 1999-2013. We can observe that the total damages caused by crime generally kept decreasing since 2000 with only few years' exception. Nevertheless, after 'the glorious times' from 2001 to 2006, the recovery rates remained at super low levels less than 1%. The great differences between statistics in each year (especially the difference between the data of 2006 and 2007) perhaps came from the characteristics of crime and the diverse historical factors like the change in policy and measurement method.

Overall, according to the discussion of criminal statistical data, we can say that there is a considerable improvement in the social security in the Czech

Republic with continuous decrease in criminal offences. However, the low clearance rates and damage recovery rates also give an implication that there is still room for police efficiency improvement in the future.

Table 2 - Recorded and recovered damages in the Czech Republic 1999-2013

Year	Recorded Damage (mil. CZK)	Recovered Damage (mil. CZK)	Recovery Rate (%)
1999	35,653	267	0.7
2000	63,409	249	0.4
2001	55,741	2,118	3.8
2002	43,289	2,394	5.5
2003	48,037	1,318	2.7
2004	48,456	2,179	4.5
2005	42,985	640	1.5
2006	24,262	835	3.4
2007	22,782	162	0.7
2008	31,626	244	0.8
2009	26,013	154	0.6
2010	24,104	100	0.4
2011	23,951	67	0.3
2012	34,215	61	0.2
2013	29,054	64	0.2

Data source: the Ministry of Interior of the Czech Republic (2004-2013)

Recorded Offenders - Gender

If we have a closer look at the statistics of crime subjects listed in Table 3, males were the majority of offenders[12] from 1999 to 2013; even though there was a slight decrease in the ratio over these 15 years, the male offenders were still found four times higher than female ones. On the other hand, there is another

[12] In this chapter, the offenders indicated recorded offenders.

noteworthy finding in statistics of repeated offenders. In 1999, the ratio of repeated offenders accounted for 28.2% of total amount of offenders. Surprisingly, in shortly 15 years, the ratio had risen highly to 52.6% by the end of 2013.

Table 3 - Recorded offenders (by sex) in the Czech Republic 1999-2013

Year	Recorded offenders (%)		
	Men	Women	Repeated offender*
1999	88.8	11.2	28.2
2000	88.1	11.9	29.7
2001	87.7	12.3	31.9
2002	87.6	12.4	39.3
2003	88.0	12.0	42.7
2004	87.6	12.4	45.2
2005	85.8	14.2	46.0
2006	86.4	13.6	46.2
2007	87.2	12.8	44.5
2008	87.5	12.5	43.7
2009	87.1	12.9	45.9
2010	86.8	13.2	47.5
2011	86.7	13.3	48.5
2012	86.3	13.7	50.0
2013	85.8	14.2	52.6

Note: * According to the Ministry of Interior of the Czech Republic (2004-2013), in the Czech police system, the term is regarded as a deliberate-crime perpetrator who had been sentenced for others deliberate crime in the past.

Data source: the Ministry of Interior of the Czech Republic (2004-2013)

In the same year, the Ministry of the Interior of the Czech Republic emphasized in their annual report that this high repeating rate can be an extremely serious problem to the society, because the high repeating rate in criminal activities represents the enhancing knowledge of police system and criminal proficiency. Besides, they also mentioned in the end of the report that

"*these data suggest that the measures taken by the state authorities focusing on the elimination of repeated crime have proven inefficient*", which we have noticed in previous statistics analyses. High repeating rate in crimes is for sure another important task the Czech government needs to care about.

Recorded Offenders - Age

In addition to the gender, we also analyze the age of the criminals. According to the classification by the MoI in annual reports, all criminals are divided into six groups in accordance with their age: up to 15 (children), 15-17 (juveniles), 18-19, 20-29, 30-59 and 60 and above (adults). Table 4 presents these age groups and each one's proportion in the total offenders during the period of 2002 to 2013.

Table 4 - Recorded offenders (by age) in the Czech Republic 2002-2013: percentage of offenders' age in total amount

Year	Age group (%)					
	0-14	15-17	18-19	20-29	30-59	60+
2002	4.18	6.21	7.10	34.88	46.17	1.46
2003	4.24	6.23	7.08	34.51	46.36	1.58
2004	3.07	5.10	7.27	34.35	48.60	1.61
2005	2.75	4.65	7.22	33.99	49.72	1.67
2006	2.47	4.73	7.39	34.61	49.05	1.76
2007	2.06	4.95	7.35	35.28	48.33	2.02
2008	2.23	4.93	7.19	34.49	49.08	2.08
2009	1.70	4.33	7.00	33.39	51.36	2.21
2010	1.43	3.57	6.28	31.52	54.71	2.51
2011	1.36	3.51	5.85	31.49	55.10	2.69
2012	1.21	3.08	5.92	31.30	55.43	3.05
2013	1.06	2.50	5.17	32.60	55.53	3.14

Data source: the Ministry of Interior of the Czech Republic (2004-2013)

We can find that the ratio of children and juvenile offenders continued to decline since 2002, so did the age group of 18-19 and 20-29. In contrast, offenders aged 30 to 59 accounted for the largest share of the total criminals, rising from 46.17% in the beginning of the statistical period to 55.53% by the end of 2013; apart from that, the proportion of criminals above 60 was also found two times higher than the rate of 2002. Nevertheless, when we compare the percentage number of each age group, we should also notice that each group has different age ranges. The uneven classification perhaps is the main reason why there is a high percentage of criminals aged 30-59 years old.

Table 5 provides a different view of the age statistics. The percentage of criminals in the population of each age group is shown in the table, and the statistics more or less meet the stereotype of young people being more impulsive and impatient. As we can see, overall people aged 18 to 29 seem to have higher potential to commit crimes than others, in spite of lower percentages in total amount of offenders as presented in Table 4, and people over 30 years old now are comparatively less violent. Nevertheless, we should still pay attention to a slight increase in the percentage of offenders in population aged above 30, as well as the reduction in the ratio of offenders among children and juveniles. The trend provides us an implication that the age of criminals is still slowly increasing over the years in the Czech Republic.

Table 5 - Recorded offenders (by age) in the Czech Republic 2002-2013: percentage of offenders in population in each age group*

Year	Age group (%)					
	0-14	15-17	18-19	20-29	30-59	60+
2002	0.32	1.92	3.19	2.52	1.32	0.09
2003	0.32	1.91	3.19	2.49	1.30	0.10
2004	0.24	1.57	3.26	2.53	1.35	0.10
2005	0.22	1.45	3.27	2.58	1.37	0.10
2006	0.20	1.49	3.44	2.72	1.34	0.10
2007	0.18	1.63	3.56	2.96	1.37	0.12
2008	0.18	1.57	3.32	2.79	1.32	0.12
2009	0.14	1.43	3.28	2.76	1.38	0.12
2010	0.11	1.14	2.68	2.43	1.33	0.12
2011	0.10	1.23	2.64	2.52	1.37	0.13
2012	0.09	1.18	2.73	2.54	1.37	0.14
2013	0.08	1.05	2.63	2.80	1.43	0.15

Note: * The population of each group is the statistical data of January 01 of each year.

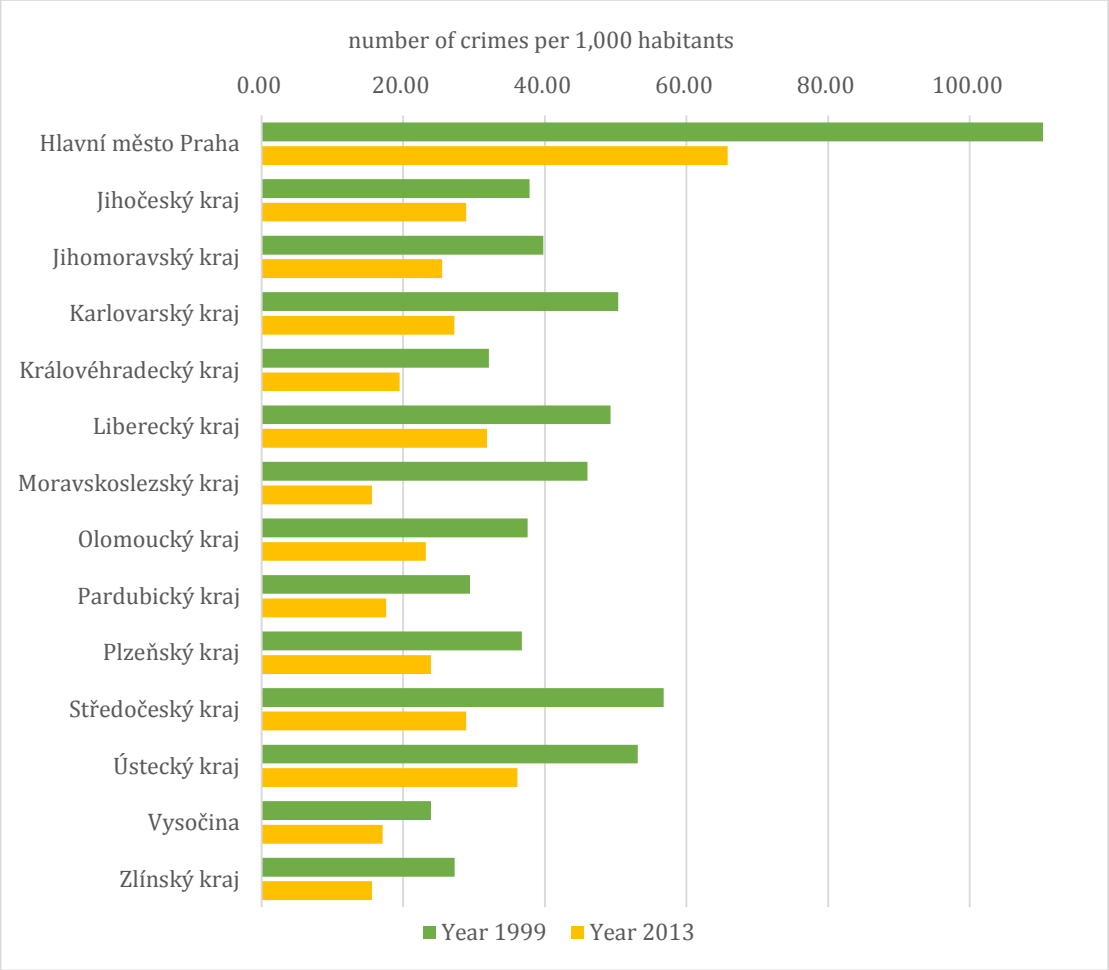
Data source: the Ministry of Interior of the Czech Republic (2004-2013)

2.2.2 Regional Statistics

Recorded Crimes

In the last part, we again focus on the crime development, but at regional level. We use the crime rate, which means the number of crimes per 1,000 habitants, to capture the development. Since the crime data of total regions are too huge, we therefore choose the statistics of beginning and the last year from our dataset, respectively 1999 and 2013, to show the rough picture of regional crime environment, as presented in Figure 9.

Figure 9 - Regional recorded crime rate in 1999 and 2013



Data source: the Ministry of Interior of the Czech Republic (2004-2013) and its private-use data

We can see that Hlavní město Praha, the capital of the CR, had the highest crime rate among all regions in both selected years. The result does not seem surprising at all, as big cities are usually considered to be hotbeds of crime. Despite this unpleasant result, the situation of criminal activities was gradually improving in Hlavní město Praha over the years. Its number of crimes dropped dramatically from approximately 111 cases per 1,000 habitants in 1999, to 65.8 cases in 2013. On the other hand, Ústecký kraj and Liberecký kraj had the second and third highest crime rate in the Czech Republic in 2013, respectively 36.1 and 31.8 criminal offences every thousand habitants.

These statistics once again confirm the uneven regional development, especially the north-Bohemian regions, as we mentioned in the previous section of regional education development. This result also indicates the existence of unequal regional development, and the problems arise along it should be concerned by the Czech government. Nonetheless, in general all Czech regions showed the declining trend in crime rates, even though the decreasing ratio varied region by region. Therefore, we can still say that the overall regional performance of crime got improved in the period of 1999-2013.

Chapter 3 Literature review

After the introduction of education and crime of the Czech Republic, now we are going to review both theoretical and empirical papers about the relationship between education and crime. To make our analysis more accurate, in addition to educational effect, we take other factors which may also affect crime rates, such as wage, unemployment rate, etc., into consideration as well in this chapter.

3.1 Education and Crime

Becker (1968) firstly developed an 'economic' framework of the opportunity cost in illegal behaviors, which provides a good description of whether committing crimes or not. The level of crime rates depends on the risk of being arrested, punishment and difference between the potential benefits and costs in committing crimes. Therefore, if there is higher return in the income of legal activities through the help of education than the income of illegal ones, a person will have less incentive to spend time committing criminal offences but to work/study harder.

Afterwards, based on Becker's theory, Lochner (2004) put forward a time allocation model of crime, work, and human capital investment. According to this model, the human capital (or skills), which can be acquired via education and job training, may discourage criminal offences because of both direct and indirect opportunity costs of time and potential loss in opportunity associated with prison. However, on the other hand, it is shown that the human capital may also make individuals better criminals in higher-skilled crimes such as economic crimes.

Based on these theories and the researches done by Ehrlich (1973), Witte and Tauchen (1994) and Lochner (2007, 2011), there are few assumptions of the influence of schooling on crime concluded:

1. education raises one's wage, which at the same time increases the opportunity costs of committing crime
2. school attendance crowds out the available time for criminal activities
3. education can affect an environment of crime through one's social networks or peers
4. education may alter preferences of taking risk to commit crimes

Have these theories been proved in empirical studies? Lochner and Moretti (2001) found the significant influence of high school graduation on criminal activities through using individual-level, state-level and self-report data in the US analysis. Huang and Chen (2007) used the Chinese data in the period of 1978-2005, and the outcome suggested that higher enrollment rate of junior high school can lower overall crime rate. In addition, Chen (2008) concluded that in Taiwan higher and crimes against property. Similarly, Buonanno and Leonida (2009) found that education had a negative effect on crime rate among Italian regions. These findings can be seen as the preventive effect of education on crime.

Nevertheless, the conclusions are not entirely consistent. Fajnzylber et al. (2002) used the generalized method of moments (GMM) to estimate murder cases among 39 countries in the period of 1965-1995, and robberies in 37 countries during 1970–1994. Their finding presented that there was no significant or robust relation of average years of education for adults with crime rates. Another different result was found in the research of China by Chen and Li (2011). The

authors analyzed the Chinese regional data from 2000 to 2008 and found that education in elementary, junior and senior high schools could help decrease the crime rates in China, and this influence on reduction became stronger with the increase in education levels. However, university education was not helpful to reduce overall crime rates, but to increase the growth of economic criminal offences such as fraud significantly. Based on these results, they proposed the existence of uncertainty of net educational impact on crime: higher educational attainment though has a preventive effect on crime, it can also lead to criminal expansion.

In summary, in spite of some inconsistent results, most theories indicated that there can be a negative influence of schooling on criminal offences. But at the same time it should be noted that education can also be 'helpful' in high-skilled crimes such as fraud and other economic crimes. Empirical studies have shown that education indeed does not always help to reduce all types of crime. The tertiary education was found to be positively related with economic crime in some studies. Therefore, it is necessary to take education levels into consideration when analyzing the relationship between education and crime.

3.2 Macroeconomic Factors and Crime

Apart from the educational effect on crimes, there are few macroeconomic factors also considered to have great influences on criminal behaviors. Based on previous studies, we select some variables and discuss their potential effects on crime rate.

Labor Market

Firstly, as mentioned in previous section, economic models give the implication that higher job availability/employment and wage levels can be effectively against the criminal behaviors. Are the significant effects of these labor-market factors shown in empirical studies as well?

Witte and Tauchen (1994), due to data unavailability, took variables correlated with wages such as IQ and high school degree in their panel data analysis of the United States, and got the conclusion of significant influence of high wage level on crime reduction. Later on Blackmore (2003) also had the same finding of significant income effect in the research of South Africa. On the other hand, Raphael and Winter-Ebmerthe (2001) used both OLS and 2SLS models to estimate the relationship between crimes and unemployment rate by using military spending and oil costs as instruments for unemployment rates. They found significantly positive effects of unemployment on property crimes; however, there was no existence of same positive influence on violent crimes. Similarly, Chen (2008) used employment rate as an independent variable in his research of Taiwan, and he observed its inverse relationship with crimes against property as assumption.

GDP per capita

In addition to labor-market effects, other socioeconomic data have been used in analysis as well. Buonanno and Leonida (2009) and Altindag (2012) adopted the

concept of Ehrlich (1973) and Witte (1980)[13], using GDP per capita as a proxy of return to criminal activities. They all observed that GDP per capita had a positive effect on property crimes and larceny. Altindag (2012) further speculated the reason might be because GDP represents a region's wealth, and higher GDP per capita indicates greater returns associated with property crimes.

Regarding to the findings, Lin (2007) had a slightly different but interesting result in his paper. There were two kinds of international crime datasets used: one was official data reported by the police, and the other one was from the victimization surveys of households. The findings indicated that GDP has a positive relation with most crimes (even though most are not significant) with the official police crime data. The outcome was the same as what Buonanno and Leonida (2009) and Altindag (2012) concluded. Nevertheless, with the application of victimization dataset, the regression result showed that GDP was negatively correlated with all crimes. In regard to these two opposite results, Lin (2007) put forward the idea that the real effect of GDP on crime is actually negative, as the regression result shown from victimization crime data. He mentioned that: "*this difference comes from what has been known as Lipset's law: the willingness of people to have confidence in the police rises with GDP."* In addition, the trust in police makes people more willing to report the crimes to the police, therefore a positive GDP effect on crime was found with police crime data in his research.

[13] Witte, Ann D. (1980). Estimating the Economic Model of Crime with Individual Data. *Quarterly Journal of Economics 94*, pp. 57-84

Inequality

Many people also believe that high crime rates is the price of inequalities in the society. Already in the early 1980s, Blau and Blau (1982) found the socioeconomic inequalities (in racial and economic aspects) were positively related to high occurrence rate of violence as the result of people's relative sense of deprivation in the research of the US. Large effects of equality (in income and education aspects) on violent crime were also presented in the paper of Kelly (2000) in the US. Additionally, in the GMM estimation of 39 countries in the year of 1965-1995 by Fajnzylber et al. (2002), the result suggested that the Gini index affected both crimes significantly and positively. Likewise, Lio and Lu (2011) applied the GMM for the estimation of the Gini coefficient in the research of crime. Their outcome not surprisingly also showed that high Gini coefficient was associated with high rates of theft and homicide in the case of Taiwan.

Crime Clearance and Urbanization

Crime clearance and urbanization are also considered to play important roles in crime. Huang and Chen (2007) estimated the effect of urbanization rate on crime in China. Their result indicated that high urbanization rate could lead to high crime rates. For the same research purpose, Chen (2008) used population density as a proxy of urbanization in the analysis of Taiwan, and the regression result indicated significant and positive effects on thefts, violence and immoral crimes. Later, Zhang (2010) observed that higher clearance rates could decrease the occurrences of theft, violent crime and overall crime based on the data analysis of Liaoning Province in China. Lio and Lu (2011) analyzed Taiwanese data through the GMM with time dummies, and got the similar conclusion as Zhang (2010) did

that crime clearance rates had a negative influence on criminal offences such as violence, theft and overall crimes.

In this section we discuss about the influence of socioeconomic factors on crime. To sum up, empirical evidences showed a significant negative relationship between wage and crime. Similarly, higher employment rate was also found to lower crimes against property. On the other hand, unemployment rate and urbanization level positively affected overall crimes and specific crime types as thefts, violence and immoral crimes. Apart from it, socioeconomic inequality was considered to be another important factor, which showed its positive relation with violent and property crimes. In comparison with these consistent results, the effect of GDP on crime seems relatively ambiguous, but still tended to be positive. The last factor of crime clearance was observed to influence overall criminal activities, as well as theft and violent crime negatively.

3.3 Demographic Factors and Crime

Furthermore, there are crime researches indicating the significant demographic effects on an area's crime.

Gender Ratio

Normally, men are thought to be more violent and commit more crimes than women. According to the crime data of the Czech Republic, the recorded offenders were indeed mainly males, as previously shown in Table 3. Can we thus say that higher proportion of males leads to higher crime rate?

Chen (2008) used male-to-population ratio data in crime rate analysis, and

found its positive effect on violence and automobile theft among Taiwanese regions. Nevertheless, Blackmore (2003) had different conclusion: he used the ratio of women to men in the panel data analysis of South Africa. Even though women are generally expected to commit fewer crimes relative to men, a positive influence of the female ratio in population was surprisingly found on most of crime types. Blackmore (2003) proposed some possible explanation: first of all, there are some crime types such as shoplifting which both women and men are capable of committing, the gender ratio thus does not (or cannot) show a great influence on these crimes specifically. Moreover, people usually tend to find some weaker victims; therefore, within the area with higher women to men ratio, there are also more women threatened by crimes since more people (especially females) consider them as targets, which results in higher crime rate.

Population Density

Another common used demographic factor is population density. We have mentioned that Chen (2008) used this factor as a proxy of urbanization for the analysis of Taiwan and found its inverse relationship with most crime (although few show their significance). But the opposite result was found in the study of China by Chen and Li (2011). Their 2SLS analysis revealed a positive influence of population density on total crime rate. In fact, Chen (2008) has mentioned both positive and negative influence of population density on crime rates: with higher population density, it is easier for offenders to 'find victims', which leads to higher crime rate; however, at the same time it can be easy as well to be caught after committing crimes in more densely populated areas. Accordingly, it is difficult to find the real effect of population density on crime and that is why there can be big differences in these empirical findings.

Age

Age is also one the important demographic factors. Blackmore (2003) used the data from South Africa and observed the significant age effects on crime. The author used the proportion of people aged 15-34 to whole population as independent variable. The significantly positive influences on most of property crimes and murder were found, when its negative relations with assault and household burglary were shown. Regarding these negative effects, Blackmore (2003) gave the possible explanation that it might be because of the incomplete data. As mentioned in Chapter 2, victims usually have low incentive to report such unpleasant offences, for example, assaulting, and this potential problem of dark figure could cause the biased data. Another possibility is that the main offenders were not within this age group, therefore the real influence could not be observed and only inverse relation were found.

On the other hand, Chen (2008) used the proportion of people in several age groups (18-23, 40-54, 55-64 and over 65) to whole population as explanatory variables in the research of Taiwan, and the regression results showed the significantly negative effects of ratio of people aged 40-54 in total population on violent, sexual and property crimes. Chen (2008) mentioned that in Taiwan the main criminals were at the age of 23-37 in 2006. Therefore, the same reason from Blackmore (2003) that the offenders were actually out of the selected age group, so there was no positive relation, but a negative influence of the proportion of people aged 40-54 presented. Based on the findings from both studies, we may conclude that younger people are thought to commit crimes more, so the positive influence of younger age group (or the negative effects of elder age group) on crimes can be expected to be observed.

In conclusion, demographic factors such as men-to-population ratio and population density have vague impacts on crime. We assume that it is because the cultural or even national difference; perhaps one area's development stage is a key reason of it as well. However, even it is hard to assert how exactly demographic factors affect crime, we cannot neglect their significant effects shown in these researches. Hence, it is still necessary to estimate these demographic impacts on crime. On the other hand, age seems to have clearer and more significant influence on crime rates. The higher ratio of young people in whole population was found to have a positive effect on most of criminal offences, when the inverse relation between elder age group and crime rate were observed.

Chapter 4 Hypotheses

On the basis of the review of economic models and research findings, even though the empirical evidences not always show the same results, we are able to make assumption that, in our analysis of the Czech Republic:

- **H_1: Higher educational attainment rate helps to decrease occurrences of most types of crime, but higher attainment ratio of tertiary education is expected to increase economic crimes.**

  We expect lower crime rate because getting education can change the preference to taking risks of being criminals, and it also crowds out the available time to committing crimes. However, since people can attain more professional knowledge in tertiary education, they may have more abilities to commit the highly-skilled crime such as economic crime, thus its crime rate is expected to rise when there is a higher attainment rate of higher education.

- **H_2: High GDP per capita is related to high crime rates.**

  High GDP per capita indicates high return to criminal activities, therefore people have more incentives to commit crimes.

- **H_3: Higher employment rate can be helpful in reduction of property crime rates.**

  High employment represents better labor market condition. It may reduce people's pursuit of money and the criminal activities against property thus decrease as well.

- **H_4: Higher police efficiency (or higher crime clearance rate in the thesis) can lower crime rates.**

  More efficient police force means higher probability for offenders to be caught, which can frighten people out of committing crimes.

Even though the empirical influences of demographic factors are rather ambiguous, we can make the assumption based on the past statistical data and social stereotypes that:

- **H_5: The lower male ratio to population, the lower crime rates**.

  Men are usually thought to be more violent and compulsive than women, and the Czech statistics of high male proportion in total criminals confirms this gender stereotype.

- **H_6: High population density is associated with more criminal activities**.

  In more densely populated area, it is also easier to for criminals to find targets, as well as a higher chance to have conflicts. Therefore, higher crime rates are expected in more crowed area.

- **H_7: The higher ratio of young population aged 15 to 29 in the society, the higher crime rate it is expected to be.**

  The assumption is based on official criminal records that in the age group of 15-29 there is the highest proportion of criminals; besides, the young people are considered to be more impulsive and easy to lose their control, thus may commit more crimes than others.

In addition to these theoretically or empirically influential element on criminal activities, other factors like wage, unemployment rate, urbanization level

and socioeconomic inequality are also considered to be important social elements in crime analysis. The wage level was thought (and proved) to have negative effect on crime: the higher wage level, the lower crime rate. Conversely, the inequality, urbanization level and unemployment rate were found to have considerable effects on violence and crime against property, as well as overall crime. Nevertheless, owing to the unavailability of data, we fail to add these influences in our analysis. For a more complete crime analysis, hopefully the database that covers the entire new regions (NUT3) with longer time periods can be available in the Czech Republic in the near future.

Chapter 5 Methodology

This chapter consists three sections: a brief information of the panel dataset is provided in the first part, as well as the definition of each variable. Two analytical models applied in the thesis: fixed-effect model and GMM are introduced in the second and the last part of the chapter.

5.1 Data

The panel of annual data covers the period of 2000-2012, and the analysis units are fourteen administrative regions of the Czech Republic. The data is chosen based on the discussion in previous chapters and its availability. Due to the change in estimation units from NUTS 2 to NUTS 3 in 2004/2005, the changes in the unemployment measurement method in mid-2004 and 2013, as well as police reform in 2010, most of data are not available in public but only for internal use, and needed to be recalculated to fit in different classification. That is why we choose year 2000 to 2012 as the estimation period, and why important factors such as wage, unemployment rate, urbanization level and socioeconomic inequality unfortunately cannot be included into our analysis. In addition to these omitted variables, we should also be aware of the possible biases from the problem of dark figures in official criminal records.

To make our analysis easier, we roughly divide the dataset into three categories: crime and police, education and social data. Crime and police data come from both public- and private-use statistics provided by the MoI and the

Police of the Czech Republic (*"Policie České republiky",* Czech Police). On the other hand, the main sources of education and social data are the regional yearbooks published by the CZSO and Eurostat statistics. However, among those databases there is incomparability of population density data, hence we get this demographic factor from OECD database. The selected variables and their summary statistics are presented in Table 6.

Table 6 - Summary statistics

Category	Variable	Mean	Std. Dev.	Min.	Max.
Crime	C_VIO	2.26	0.80	1.06	4.21
	C_IMM	0.22	0.08	0.09	0.66
	C_PROP	23.05	14.32	9.03	88.17
	C_ECON	3.70	1.27	1.87	9.47
	C_TOTAL	35.63	16.38	17.65	104.73
Police	POLICE_VIO	74.49	10.19	44.07	93.47
	POLICE_IMM	81.63	9.92	50.21	100.00
	POLICE_PROP	26.27	7.63	6.17	45.26
	POLICE_ECON	67.63	16.92	34.66	98.18
	POLICE_TOTAL	46.61	9.72	18.28	65.72
Education	EDU2	37.83	4.80	19.15	44.16
	EDU3	31.70	3.44	24.74	43.89
	EDU4	10.41	4.70	4.91	31.57
Social	l_GDP_PC	12.53	0.29	12.06	13.59
	EMP	54.81	2.44	49.17	60.34
	MALE	48.95	0.38	47.37	49.63
	l_POP	4.98	0.85	4.17	7.85
	AGE2	21.11	1.83	16.88	24.25
	AGE3	43.19	0.92	40.38	45.14
	AGE4	20.71	2.02	16.63	25.13

In the following paragraphs we continue to introduce each category and the definition of independent variables.

5.1.1 Education

According to the definition from OECD (2012), educational attainment refers to the highest level of education completed by a person, presented as a percentage of all population in the chosen group. Based on the statistics[14] from the Ministry of Labour and Social Affairs (*"Ministerstva práce a sociálních věcí"*, MoLSA), there are four types of educational attainment as below:

- Basic education and none $(EDU1)(\%)$: it equals to ISCED 97 classification of level 0, 1 and 2. It covers the education in basic school (*"základní škola"*) and lower-gymnasiums (grade 1-4 in the eight-year programs) or non-education. In order to prevent the problem of multicollinearity, we do not use this variable in the regression.
- Secondary education without A-level exam $(EDU2)(\%)$: it equals to ISCED 97 classification of partial level 3. It contains the education in majority of secondary vocational schools (*"střední odborné učiliště"*).
- Secondary education with A-level exam $(EDU3)(\%)$: it equals to ISCED 97 classification of partial level 3 and level 4. The education in gymnasiums, secondary technical schools (*"střední odborná škola"*), some of secondary vocational schools and post-secondary extensions (*"nástavbové studium"*) is in this classification.

[14] The subjects of labour force investigation are at age 15 and above.

- Higher education ($EDU4$)(%): it equals to ISCED 97 classification of level 5 and 6. The education in tertiary professional school and higher education institution is included.[15]

5.1.2 Social

In this category there are five variables chosen for the analysis, respectively are GDP per capita, employment rate, male-to-population ratio, population density and age proportion of population. The first two explanatory variables describe the macroeconomic situation, and the rest three provide regional demographic information.

Demographic Factors:

- Male-to-population ratio ($MALE$)(%): males divided by total population.
- Population density (POP) (persons/km^2): population divided by land area in square kilometers. In this thesis we take its logarithm value (l_POP) for analysis.
- Age proportion of population: selected age group's proportion of total population. There are totally six age groups used in the annual reports from the MoI (2007-2013), and people at age of 15-30 were shown to have higher probability to commit crimes than others.[16] Considering the limited availability of age data from the CZSO and the classification from the MoI, we divide whole population into four age groups and calculate each one's ratio in population:

[15] For more detailed educational classification, please see Figure 1.

[16] For more detailed statistics, please see Table 5.

- $AGE1(\%)$: proportion of people aged below 15 in population (age 15 is not included). In order to prevent the problem of multicollinearity, we do not use this variable in the regression.
- $AGE2(\%)$: proportion of people aged 15-29 in population.
- $AGE3(\%)$: proportion of people aged 30-59 in population.
- $AGE4(\%)$: proportion of people aged over 60 years old in population.

Macroeconomic Factors:

- GDP per capita $(GDP\_PC)(CZK)$: nominal GDP per person. In this thesis we take its logarithm value (l_GDP_PC) for analysis.
- Employment rate $(EMP)(\%)$: it is so-called employment-to-population ratio. In the thesis we calculate the ratio by using employed persons over population of age 15 and above[17].

5.1.3 Crime and Police

This data category comprises two main factors: crime rates and police efficiency in order to depict the crime environment in the Czech Republic. As mentioned in previous chapter, not only educational attainment but also other factors may affect different kinds of crime variously. Therefore, apart from the overall data, it is necessary to observe the influence more specifically. In the annual reports from the MoI, criminal offences are categorized into several types

[17] Each organization has different measurement of employment rate. Eurostat and OECD statistics include employment rate as percentage of working age population (between 15 or 20 and 64 years old). Taking other variables' measurement into account, we adopt the same method as the CZSO applies in year 2012, using employed persons over population of age 15 and above for employment rate calculation, to make the analysis easier.

as shown in Table 7.[18] Taking these official criminal types as well as characteristics of these crimes into account, we select another additional four crime sub-categories as dependent variables for the estimation, which can be found in the table as well.

Table 7 - Criminal types

Crime Code			Crime*
101-902			Offences, total
	101-664		General Crimes
		101-190	Violence
		101-106	Murders
		201-290	Immoral
		311-590	Crimes against property
		311-390	Burglaries
		411-490	Thefts
		611-664	Other crimes
	721-790		Remaining crimes
	801-890		Economic offences

*The crime types with gray shadows are selected for our analysis.

Data source: the Police of the Czech Republic (2008-2014)

Crime Rates:

- Total crime rate $(C\_TOTAL)(‰)$: the ratio refers total crimes per 1,000 inhabitants. We use it as the dependent variable in our econometric model.
- Violent crime rate $(C\_VIO)(‰)$: number of violence offences per 1,000 inhabitants, murders, robberies and causing intentional bodily harm included.

[18] For more detailed list of criminal offences and their crime codes please check: The Ministry of Interior of the Czech Republic. (2004-2013). *Report on Public Order and Internal Security in the Czech Republic*

- Immoral crime rate $(C\_IMM)(‰)$: number of immoral offences per 1,000 inhabitants, including rapes, sexual abuses and sexual deviations.
- Rates of crimes against property $(C\_PROP)(‰)$: number of crimes against property per 1,000 inhabitants, including thefts, burglaries and damaging another's property.
- Economic crime rates $(C\_ECON)(‰)$: number of economic crimes per 1,000 inhabitants. Credit fraud, embezzlement and unauthorized possession of a payment card are included.

Police Efficiency:

The other important factor is police efficiency. In the thesis we use clearance rate as a proxy of this variable. Higher clarified rate is expected to indicate higher police efficiency. Likewise, we calculate clearance rate of total crime and four other chosen criminal types for the estimation:

- Police efficiency $(POLICE\_TOTAL)(\%)$: proportion of clarified criminal offences in total ascertained crimes. And the rest of clearance rates are calculated in the same measurement method.
- Police efficiency in violent crimes $(POLICE\_VIO)(\%)$
- Police efficiency in immoral crimes $(POLICE\_IMM)(\%)$
- Police efficiency in crimes against property $(POLICE\_PROP)(\%)$
- Police efficiency in economic crimes $(POLICE\_ECON)(\%)$

5.2 Analytical Model

5.2.1 Panel Data Analysis: Fixed-Effects Model

Since the data used for the analysis is panel dataset, as Lin (2007) and Chen (2008) mentioned, simply using OLS may cause ignorance of individual and time difference, and then lead to coefficient inconsistency. In order to avoid this problem, it is necessary to apply either fixed effect model or random effect model. Besides, in chapter 2 we have talked about the issue of uneven regional development in the Czech Republic, especially north-Bohemian regions. Taking these region-specific characteristics into consideration, we decide to use fixed effect model for analysis.[19] Therefore, our econometric model is set up as:

$$Crime_{i,t} = \alpha_i + \beta_0 + \beta_1 Edu_{i,t} + \beta_2 Social_{i,t} + \beta_3 Police_{i,t} + \varepsilon_{i,t} \qquad (1)$$

where i and t represent entity (region) and time period (year) respectively, α_i is a regional fixed effect and $\varepsilon_{i,t}$ means the residual. In addition, as previously defined in the data section, $Crime_{i,t}$ is the crime rate set, $Edu_{i,t}$ is the educational attainment, $Social_{i,t}$ is the set of demographic and macroeconomic variables, and $Police_{i,t}$ is the clearance rate of crimes, which represents the police efficiency in the Czech Republic.

Furthermore, in reference to researches done by Buonanno and Leonida (2009), as well as Lio and Lu (2011), we include time dummies to illustrate the influence of specific yearly changes in government policies of crime prevention,

[19] In Hausman test we can reject the null hypothesis that the random-effect model is preferred. This is another reason why we decide to apply the fixed-effect model for the panel dataset.

which are assumed to be the same among all regions. The econometric model thus can be rewritten as:

$$Crime_{i,t} = \alpha_i + \beta_0 + \beta_1 Edu_{i,t} + \beta_2 Social_{i,t} + \beta_3 Police_{i,t} + \sum_{t=2}^{13} \gamma_t D_t + \varepsilon_{i,t} \quad (2)$$

where D_t is time dummy, t = 1 is the base year 2000. Both regression models (with and without time dummies) are used in our analysis in order to present the possible omitted time effects on crime.

5.2.2 Dynamic Panel Data Analysis: GMM

Even though by using the fixed effect in the panel dataset, we are able to capture the specific character of each region, Lio and Lu (2011) pointed out that there can be the existence of criminal inertia problem, which means that the criminal record in the past may have some influence on today's crime rate. The ignorance of this problem can make coefficients inconsistent and lead to an unreliable and biased result. Therefore, it is important to take this dynamic phenomenon into consideration in analysis. According to Fajnzylber et al. (2002), Buonanno and Leonida (2009) and Lio and Lu (2011), we can estimate the dynamic phenomenon by adding the lagged dependent variable in the regression. This is so-called dynamic panel data model. In reference to the works by Bond (2002), Liu and Kang (2007) and Lio and Lu (2011), the general expression of dynamic equation can be stated as:

$$y_{it} = \alpha y_{i(t-1)} + \beta' x_{it} + (\eta_i + \upsilon_{it}), \quad t = 2, \dots, T \quad (3)$$

where y_{it} represents the current dependent variable, $y_{i(t-1)}$ is the lagged one period value. x_{it} is a vector of explanatory variables. η_i is the individual effects,

which are different among the regions, but do not change with the time. v_{it} represents disturbances, which fulfill the condition $E(v_{it} \mid x_{i0}, \dots, x_{iT}, \eta_i) = 0$.

Nevertheless, the dynamic panel can further cause the problems of autocorrelation from the new lagged-value regressor and heterogeneity of region-specific effect, as Sumit (2012) mentioned. By applying the GMM in estimation procedure, we are able to solve the problems and get more efficient estimates. The concept of GMM estimator was first formalized by Hansen early in 1982, but Arellano and Bond (1991) made it in a wider applicability. Arellano and Bond (1991) applied the first difference transformation, which means the difference between the equation at time t and at time (t-1), to remove unobserved region fixed effects η_i. For instance, following the instruction from Liu and Kang (2007), the first-difference of equation (3) can be written as:

$$\Delta y_{it} = \alpha \Delta y_{i(t-1)} + \beta' \Delta x_{it} + \Delta v_{it}\,, \quad t = 3, \dots, T$$

$$\text{or } (y_{it} - y_{i(t-1)}) = \alpha(y_{i(t-1)} - y_{i(t-2)}) + \beta'(x_{it} - x_{i(t-1)}) + (v_{it} - v_{i(t-1)}) \qquad (4)$$

After the effect elimination, the instrument matrix Z_i can be applied for the first-difference of equation estimation. It is important to know that the instrument matrix Z_i contains the two-period-and-longer lagged value of dependent variable, as well as lagged value (or complete time series, depending on the endogeneity) of independent variables. Besides, the matrix should fulfill the condition that $\mathrm{E}[Z_i \Delta v_{it}] = 0$. Further, based on the previous discussion, we add the dynamic effect (the lagged dependent variable) into the equation (1). The econometric model can be restated as:

$$Crime_{i,t} = \alpha_i + \beta_0 + \beta_1 Crime_{i,t-1} + \beta_2 Edu_{i,t} + \beta_3 Social_{i,t} + \beta_4 Police_{i,t} + \varepsilon_{i,t} \quad (5)$$

Likewise, we can rewrite the equation (2) with dynamic information as:

$$Crime_{i,t} = \alpha_i + \beta_0 + \beta_1 Crime_{i,t-1} + \beta_2 Edu_{i,t} + \beta_3 Social_{i,t} + \beta_4 Police_{i,t} + \sum_{t=3}^{13} \gamma_t D_t + \varepsilon_{i,t} \quad (6)$$

where $Crime_{i,t-1}$ is the one-year lagged value of dependent variable $Crime$ in the region i. After the model introduction, now we continue to analyze the regression result.

Chapter 6 Result

In this chapter we are going to present the regression result with fixed-effects and GMM estimation. The outcomes are shown in Table 8 to Table 12, and each table respectively presents the analysis outputs of total crime rates, and the crime rates of chosen sub-categories, such as violent crime, immoral crime, property crime and economic crime.[20] In each table column (a) and (b) show the results from fixed-effect model estimation, and column (c) and (d) present the results from the GMM estimation. In addition, column (b) and (d) are the results with the consideration of potential time influence (by adding time dummies into regression), while column (a) and (c) do not consider the effect. In order to make the comparison of outcomes among two estimation methods and time effects more clear, we discuss the results in accordance with crime types: first of all, we begin with the result of total crime rate, and then discuss the outcomes of the rest of the types of criminal offences.

6.1 Regression Result: Total crime

Column (a) in Table 8 shows significant negative influences of male-to-population ratio and tertiary education (even though it is much weaker than the former one) on total crime rates, while the positive effects of employment rate and population density are found. After adding the time effects into the regression, as shown in

[20] For more detail of criminal categories, please see the chapter: 5.1.3 Crime and Police.

column (b), the statistical significances of employment and tertiary education attainment disappear. Instead, the police efficiency, of which the clearance rate is used as a proxy, shows a negative influence on total crime rate, while secondary education with A-level exam and proportion of people aged 30-59 and over 60 are found to have positive effects.

On the other hand, in the GMM estimation, it is worthy to note that the variable CRIME-1 shows a significantly positive effect on total crime rate in both models with and without time effect. It indicates the existence of criminal inertia as mentioned in previous chapter, so the models under GMM estimation are more reliable. If we continue to the AR (2) and Sargan test result, the model with time effect in column (d) seems to be a better choice. The null hypothesis of AR (2) test is no autocorrelation of second order, and the null hypothesis of Sargan test is that the over-identifying restrictions are valid, which means that the instruments are effective. In AR (2) test, both models cannot reject the null hypothesis at 10% level of significance, which indicates that in both models (with and without time effect), there is no second-order serial correlation of the error term. Nevertheless, we can reject the null hypothesis of Sargan test in the model without time effect at the 1% significance level. The result shows the ineffectiveness of instruments, while the model with time effect shown incolumn (d) cannot be rejected at the same significance level.

In terms of the test result and significance of dependent variables[21], based on previous discussion, the dynamic panel model with time effect presented in

[21] In both fixed-effect model and GMM, some of the time dummies are statistically significant, which are not disclosed in the regression tables. It also indicates the importance of time effect.

column (d) is thought to illustrate each variable's influence on total crime better. It basically shows a similar result to the one in column (b): the clearance rate and male-to-population ratio are found to affect total crime rate negatively, and secondary education with A-level exam and ratio of population aged 30-59 years old have positive influences. The significance of population density disappears under the GMM estimation.

Overall, the regression results are quite out of our expectation: only clearance rate shows the same impact as our assumption that higher clearance rate (or we can say higher police efficiency) lowers criminal incidents. The other variable, for example, higher attainment rate of secondary education with A-level exam, is expected to lower crime rates. This speculation however does not come true in our analysis. Instead, people perhaps obtain more knowledge and skills from the education, and therefore are able to commit more crimes. In addition to this, male ratio to population is also a surprising exception. Its inverse relationship with total crime rate breaks traditional gender stereotypes: if the male ratio increases by 1%, when all other things being equal, there will be a reduction of 0.7169‰ in total crime rate. Blackmore (2003) has put forward some possible explanations to this negative relation[22], but more data is still needed for further analysis to prove the statement. The last important finding is the statistical significance of proportion of people aged 30-59. We expect that young people are more compulsive and tend to commit more crimes, so the higher proportion of population aged 15-29, the higher crime rate will be. But the result unfortunately does not support this argument.

[22] Please see the chapter: 3.3 Demographic Factors and Crime.

Table 8 - Regression result: Total crime

	C_TOTAL			
	FIXED-EFFECT MODEL		GMM ESTIMATION	
	(a)	(b)	(c)	(d)
CRIME-1	--	--	0.447 (0.057) ***	0.584 (0.078) ***
CONS	647.665 (195.815) ***	222.151 (455.381)	-1.553 (0.857) *	0.849 (1.167)
EDU2	-0.179 (0.328)	0.143 (0.402)	0.255 (0.352)	0.313 (0.247)
EDU3	0.341 (0.237)	0.692 (0.217) ***	0.718 (0.270) ***	0.545 (0.177) ***
EDU4	-0.760 (0.441) *	-0.445 (0.415)	-0.111 (0.372)	-0.068 (0.228)
l_GDP_PC	0.111 (7.512)	8.160 (11.311)	13.992 (7.074) **	5.651 (8.096)
EMP	0.600 (0.202) ***	-0.232 (0.234)	0.338 (0.152) **	-0.149 (0.158)
MALE	-19.082 (3.301) ***	-18.255 (3.799) ***	-11.047 (2.216) ***	-7.169 (2.217) ***
l_POP	46.280 (15.130) ***	64.745 (23.405) ***	-9.820 (21.140)	2.002 (16.558)
AGE2	1.796 (1.404)	2.987 (1.994)	-2.481 (1.647)	0.747 (2.158)
AGE3	-0.404 (1.021)	3.516 (1.824) *	-1.231 (0.611) **	3.167 (1.197) ***
AGE4	2.184 (1.476)	3.912 (1.758) **	-0.224 (1.102)	1.139 (0.974)
POLICE	-0.101 (0.079)	-0.214 (0.081) ***	-0.161 (0.061) ***	-0.148 (0.065) **
Time Eff.	No	Yes	No	Yes
R^2	0.98	0.99	--	--
Adj R^2	0.98	0.99	--	--
		Test (p-value)		
AR(2)	--	--	0.1663	0.9003
Sargan	--	--	0.0026	0.0416

Note: There are 182 observations in the fixed-effect model, and 154 observations in the GMM. All fourteen Czech regions (NUT3) are included in the period of thirteen years from 2000 to 2012. The values in parentheses are heteroskedasticity autocorrelation consistent (HAC) robust standard errors. The variable POLICE means the clearance rate of crime which is the same as the dependent variable, and the variable CRIME-1 is the dependent variable's one-year lagged value. ***, ** and * represent the level of coefficient significance, respectively are 1%, 5% and 10%.

6.2 Regression Result: Crime sub-categories

After discussing the regression result on total crime, now we turn to look at the outcomes of selected sub-categories of crimes. According to the discussion in the previous section, we believe that the models with time effect, in other words, the column (b) and (d), are able to define the variables contributing toward the crime rate better. Therefore, we are going to discuss mainly the results of models with time effect. Firstly, we start with the analysis of violent crime, followed by the regression result of crime against human dignity, property crime and economic crime.

6.2.1 Violent Crime

Under the fixed-effect model (b) in Table 9, the secondary education with A-level exam displays a positive effect on violent crime, so do the population density and the percentage of population aged above 30. In opposition, the employment rate is observed to affect the crime negatively. If we further apply the GMM in the regression, the lagged value of dependent variable again shows a positive effect on violent crime rate, which indicates that it is an appropriate action to apply GMM estimation. Comparing the two models, even though model (c) has higher p-value in AR (2) test, we cannot reject the null hypothesis of Sargan test at 1% significance level in the other model. It implies the instruments are more effective in model (d), in spite of its still relatively low value of 0.0149. Therefore, we still consider that the model with time effect can reveal more information of variables towards crime rate.

As column (d) shows, most of variables which previously showed great influences on violent crime lose their significance. Nevertheless, the secondary education (both with and without A-level exams) is found to play an important (and positive) role in violence. It is again a surprising finding, since committing violence is usually considered to be less skillful, and the education is supposed to educate people to 'behave well'. Hence, we expect a negative relation rather than a positive one. There may be some biases from variable omission or the instrument choice problem, which may be the reason of low p-value in Sargan test. Unfortunately, so far we cannot propose a convincing argument over this. More in-depth discussion is required to explain the positive relation among secondary education and violent activities in the Czech Republic.

Table 9 - Regression result: Violent crime

	C_VIO			
	FIXED-EFFECT MODEL		GMM ESTIMATION	
	(a)	(b)	(c)	(d)
CRIME-1	--	--	0.448 (0.087) ***	0.602 (0.134) ***
CONS	63.724 (30.605) **	-91.519 (53.271) *	0.254 (0.102) **	0.148 (0.127)
EDU2	0.032 (0.048)	0.044 (0.041)	0.040 (0.030)	0.039 (0.015) **
EDU3	0.063 (0.052)	0.087 (0.040) **	0.067 (0.031) **	0.053 (0.017) ***
EDU4	0.007 (0.047)	0.007 (0.055)	-0.009 (0.031)	0.015 (0.021)
l_GDP_PC	0.024 (0.705)	0.660 (1.144)	0.484 (0.520)	0.889 (0.601)
EMP	-0.072 (0.030) **	-0.058 (0.022) **	-0.030 (0.035)	-0.010 (0.026)
MALE	-1.055 (0.244) ***	0.008 (0.370)	-0.885 (0.275) ***	-0.256 (0.172)
l_POP	1.333 (4.974)	9.349 (4.480) **	-6.210 (2.895) **	0.721 (3.204)
AGE2	-0.195 (0.261)	0.216 (0.259)	-0.264 (0.190)	0.211 (0.156)
AGE3	-0.147 (0.148)	0.573 (0.234) **	-0.508 (0.110) ***	0.233 (0.192)
AGE4	-0.256 (0.219)	0.483 (0.271) *	-0.701 (0.171) ***	0.001 (0.183)
POLICE	-0.004 (0.007)	0.000 (0.008)	-0.007 (0.004) *	0.000 (0.005)
Time Eff.	No	Yes	No	Yes
R^2	0.90	0.93	--	--
Adj R^2	0.88	0.91	--	--
		Test (p-value)		
AR(2)	--	--	0.9679	0.8120
Sargan	--	--	0.0008	0.0149

Note: There are 182 observations in the fixed-effect model, and 154 observations in the GMM. All fourteen Czech regions (NUT3) are included in the period of thirteen years from 2000 to 2012. The values in parentheses are HAC robust standard errors. The variable POLICE means the clearance rate of crime which is the same as the dependent variable, and the variable CRIME-1 is the dependent variable's one-year lagged value. ***, ** and * represent the level of coefficient significance, respectively are 1%, 5% and 10%.

6.2.2 Immoral crime

Table 10 shows the regression result on immoral crimes. There is no variable showing any significance in the time fixed-effect model if we take the time influence into consideration. When we look at the outcome from GMM estimation, the GDP per capita and employment rate show positive impacts on immoral crime rate as column (d) displays. The higher share of population aged above 60 also shows a positive effect on crime. We may need more detailed information of immoral crimes from the authorities to be able to give a plausible explanation.

Even so, is the current result convincing enough? In comparison with outcomes of other crimes, the explanatory power of this analytical model of immoral crimes seems to be weaker: R-square values are relatively low in the fixed-effect model, and the test results are neither statistically significant with GMM estimation. Apart from it, the lagged value of crime rate also shows no significance on current year's crime rate, so we may say there is no obvious criminal inertia problem in immoral crime.

Regarding the relatively low explanatory power, we provide some possible explanations: first of all, we neglect some major factors which also affect the immoral criminal activities significantly. Secondly, the current regression model setting is not perfect enough, thus it fails to disclose complete information of impacts on crime. Lastly, the problem of dark figures in immoral crime records can lead to estimation biases as well. Zhou and Cao (2007) indicated that the victims of sexual crimes have lower willingness to report to the police in Taiwan. The same phenomenon perhaps also exists in the Czech Republic, which may be the cause of insignificant outcome in our analysis.

Table 10 - Regression result: Immoral crime

	C_IMM			
	FIXED-EFFECT MODEL		GMM ESTIMATION	
	(a)	(b)	(c)	(d)
CRIME-1	--	--	0.068 (0.082)	0.071 (0.071)
CONS	7.713 (2.839) ***	-6.886 (6.504)	-0.025 (0.026)	-0.072 (0.030) **
EDU2	0.008 (0.009)	0.011 (0.007)	0.012 (0.011)	0.007 (0.008)
EDU3	0.009 (0.007)	0.011 (0.007)	0.015 (0.009) *	0.012 (0.007)
EDU4	0.017 (0.010)	0.024 (0.015)	0.020 (0.016)	0.018 (0.014)
l_GDP_PC	-0.032 (0.101)	0.141 (0.152)	0.044 (0.114)	0.331 (0.152) **
EMP	0.000 (0.003)	0.000 (0.004)	0.006 (0.004)	0.012 (0.005) ***
MALE	-0.057 (0.031) *	0.048 (0.055)	-0.053 (0.037)	0.053 (0.062)
l_POP	-0.745 (0.243) ***	-0.049 (0.372)	-0.915 (0.491) *	-0.132 (0.533)
AGE2	-0.003 (0.025)	-0.009 (0.026)	-0.030 (0.021)	-0.022 (0.035)
AGE3	-0.025 (0.014) *	0.030 (0.031)	-0.028 (0.017)	0.039 (0.039)
AGE4	-0.008 (0.020)	0.071 (0.044)	0.005 (0.038)	0.090 (0.045) **
POLICE	0.000 (0.001)	0.000 (0.001)	-0.001 (0.001)	0.000 (0.001)
Time Eff.	No	Yes	No	Yes
R^2	0.73	0.76	--	--
Adj R^2	0.69	0.70	--	--
		Test (p-value)		
AR(2)	--	--	0.2788	0.2038
Sargan	--	--	0.0008	0.0084

Note: There are 182 observations in the fixed-effect model, and 154 observations in the GMM. All fourteen Czech regions (NUT3) are included in the period of thirteen years from 2000 to 2012. The values in parentheses are HAC robust standard errors. The variable POLICE means the clearance rate of crime which is the same as the dependent variable, and the variable CRIME-1 is the dependent variable's one-year lagged value. ***, ** and * represent the level of coefficient significance, respectively are 1%, 5% and 10%.

6.2.3 Crime against property

Table 11 presents the analysis of property crime, and we focus on the model containing the time effect still. Male-to-population ratio and clearance rate again show significant and negative relations with crime against property. Differently, we found positive effects of secondary education with A-level exam, population density and all age groups on this crime type. The outcome is similar to the analysis of total crime rates: higher clearance rate implies high police efficiency, therefore the incentives of committing crimes are much lower. Besides, in dense populated places there are more criminal opportunities and criminals have higher chances to successfully 'achieve their goals', which consequently lead to higher rates of property crime in these regions. However, apart from these, most of variables show different impacts from our assumption: secondary education with A-level exam does not help in crime reduction but perhaps improves the knowledge of criminals and makes them more skillful in property crimes.

Now we turn to the GMM estimation result. The one-year lagged variable CRIME-1 is once again found to have a positive effect on property crime. Its significance supports the necessity and correctness of GMM estimation in crime analysis. If we take a look at other variables' impacts, the significant influence of population density no longer exists, either does the impact from the share of people between 15 and 29 years old in population. Apart from it, the influence of male ratio in population decreases, but still remains negative, and the ratio of population aged over 30 still has positive effects on property crimes. Given the shortage of data and information, we will leave the surprising outcomes for further research in the future.

Table 11 - Regression result: Crime against property

	C_PROP			
	FIXED-EFFECT MODEL		GMM ESTIMATION	
	(a)	(b)	(c)	(d)
CRIME-1	--	--	0.600 (0.045) ***	0.603 (0.061) ***
CONS	872.701 (165.243) ***	22.890 (413.925)	-1.081 (0.847)	-1.303 (1.043)
EDU2	-0.224 (0.267)	0.080 (0.345)	0.402 (0.229) *	0.358 (0.211) *
EDU3	0.343 (0.233)	0.691 (0.248) ***	0.666 (0.190) ***	0.505 (0.139) ***
EDU4	-0.403 (0.367)	-0.241 (0.365)	0.256 (0.306)	0.157 (0.265)
l_GDP_PC	-7.206 (6.487)	5.936 (10.269)	3.531 (4.822)	4.031 (5.075)
EMP	0.658 (0.207) ***	0.173 (0.208)	0.131 (0.154)	-0.041 (0.146)
MALE	-18.436 (2.609) ***	-13.957 (3.060) ***	-6.542 (1.856) ***	-3.669 (2.085) *
l_POP	18.435 (18.330)	49.396 (23.124) **	-15.093 (16.370)	-0.302 (13.284)
AGE2	1.254 (1.270)	2.909 (1.571) *	-1.269 (1.061)	1.300 (1.463)
AGE3	-1.028 (1.020)	4.255 (1.667) **	-1.336 (0.577) **	3.361 (1.118) ***
AGE4	1.942 (1.431)	5.526 (1.843) ***	0.384 (1.032)	2.764 (0.947) ***
POLICE	-0.206 (0.054) ***	-0.319 (0.066) ***	-0.200 (0.053) ***	-0.145 (0.065) **
Time Eff.	No	Yes	No	Yes
R^2	0.98	0.99	--	--
Adj R^2	0.98	0.99	--	--
		Test (p-value)		
AR(2)	--	--	0.8301	0.4191
Sargan	--	--	0.0481	0.1175

Note: There are 182 observations in the fixed-effect model, and 154 observations in the GMM. All fourteen Czech regions (NUT3) are included in the period of thirteen years from 2000 to 2012. The values in parentheses are HAC robust standard errors. The variable POLICE means the clearance rate of crime which is the same as the dependent variable, and the variable CRIME-1 is the dependent variable's one-year lagged value. ***, ** and * represent the level of coefficient significance, respectively are 1%, 5% and 10%.

6.2.4 Economic crime

In the last section we are going to discuss the regression result of economic crime analysis presented in Table 12. Again we begin with the fixed-effect model coupled with the time effect as in column (b). The GDP per capita is observed to affect economic crime positively. The result is the same as what Altindag (2012) found. The reason may be, as Altindag (2012) speculated, potentially great returns from high GDP per capita in the society. On the other hand, the attainment rate of higher education and employment rate show inverse relation with crime rate. Even though we expect a positive influence of tertiary education on economic crimes, it is still reasonable to get this negative relationship, since education is meant to educate students to behave morally.

With the GMM estimation, the lagged variable CRIME-1 shows its significance, which again implies the inertia of economic crimes, and the necessity of using GMM in the dynamic panel data. The outcome is almost the same as in fixed-effect model, with slight changes in significance of higher education's attainment rate and GDP per capita. On top of that, male-to-population ratio presents a negative effect on crime, which again is out of expectation. Overall, the test result reveals relatively weaker sign of explanatory power. We can reasonably think that there are omitted factors, incorrect assumption of economic crime and again the dark figure problem in our dataset and regression model. However, we unfortunately cannot give reasonable explanations to these outcomes with current limited data.

Table 12 - Regression result: Economic crime

	C_ECON							
	FIXED-EFFECT MODEL				GMM ESTIMATION			
	(a)		(b)		(c)		(d)	
CRIME-1	--		--		0.094 (0.053)	*	0.131 (0.055)	**
CONS	26.639 (23.446)		-16.180 (69.847)		-0.116 (0.286)		0.419 (0.189)	**
EDU2	-0.023 (0.054)		-0.008 (0.049)		-0.025 (0.070)		-0.023 (0.046)	
EDU3	0.023 (0.051)		0.039 (0.045)		0.053 (0.101)		0.035 (0.067)	
EDU4	-0.026 (0.044)		-0.061 (0.033)	*	-0.092 (0.084)		-0.109 (0.045)	**
l_GDP_PC	4.418 (1.055)	***	3.829 (1.215)	***	4.979 (1.751)	***	2.649 (1.513)	*
EMP	-0.094 (0.052)	*	-0.150 (0.046)	***	-0.048 (0.060)		-0.134 (0.039)	***
MALE	-0.439 (0.324)		-0.419 (0.419)		-1.468 (0.533)	***	-1.062 (0.521)	**
l_POP	-5.870 (3.368)	*	-0.995 (4.235)		-8.698 (4.838)	*	5.862 (5.555)	
AGE2	-0.221 (0.180)		0.338 (0.273)		-0.959 (0.317)	***	0.362 (0.399)	
AGE3	-0.117 (0.162)		0.149 (0.375)		-0.279 (0.174)		0.266 (0.381)	
AGE4	-0.648 (0.187)	***	-0.405 (0.314)		-1.041 (0.189)	***	-0.352 (0.362)	
POLICE	0.016 (0.006)	***	0.002 (0.008)		0.003 (0.006)		-0.014 (0.012)	
Time Eff.	No		Yes		No		Yes	
R^2	0.84		0.91		--		--	
Adj R^2	0.82		0.89		--		--	
	Test (p-value)							
AR(2)	--		--		0.1486		0.1752	
Sargan	--		--		0.0002		0.0312	

Note: There are 182 observations in the fixed-effect model, and 154 observations in the GMM. All fourteen Czech regions (NUT3) are included in the period of thirteen years from 2000 to 2012. The values in parentheses are HAC robust standard errors. The variable POLICE means the clearance rate of crime which is the same as the dependent variable, and the variable CRIME-1 is the dependent variable's one-year lagged value. ***, ** and * represent the level of coefficient significance, respectively are 1%, 5% and 10%.

Chapter 7 Conclusion

This thesis aims to observe relationship between crime and education, as well as macroeconomic and demographic factors such as police efficiency, GDP per capita, employment rate, population density, ages and sexual composition of the society. The data is collected from fourteen regions of the Czech Republic in years 2000 to 2012. Considering the characteristic of panel data, we apply the fixed-effect model in the data analysis. Additionally, in case of the modification of policies and measurement methods of chosen variables, we add the time dummies into the regression model to capture possible time effects. Furthermore, empirical evidence found that past criminal record can affect today's crime rate. In order to avoid a possible regression bias arising from the criminal inertia problem, we use one-year lagged value of crime rate as another explanatory variable to include this effect, and this new regression model is called dynamic panel data. At last, we apply generalized method of moments in our crime analysis to prevent the estimation errors from autocorrelation and heterogeneity caused by the dynamic dataset.

We use the total crime data as our main observation target. In order to see more precisely how the chosen factors affect criminal activities, we choose four additional types of criminal offences and run the regression on their data as well. Since we find significance of time dummies and lagged dependent variable, and AR (2) test and Sargan test show comparatively high p-values, we believe that the GMM estimation with time effect is able to illustrate the influence of each variable

better. Therefore, we will make conclusion based on the GMM result including time dummies in the regression model (as presented in column (d) in the regression tables).

First of all, our findings show that the tertiary education may reduce the rate of economic crimes, but the secondary education with A-level exam in opposite plays an important role in occurrence of overall crimes, violent crimes and crimes against property. These outcomes are a bit different from expectation, but it does not mean that the result is not reasonable at all. For example, although the attainment of tertiary education is considered to help to increase the highly skillful (or we may say 'knowledge required') criminal activities like economic crimes, the education itself also educates people to be law-abiding citizens. Therefore, the presence of inverse relationship between the higher education and economic crime is not impossible. On the other hand, however, the positive influence of secondary education with A-level exam on crime is still quite surprising to us. We propose some possible explanations of criminal phenomena that the secondary education provides students not only the theories in books, but also practical knowledge that can be applied in crimes, which may be helpful for the increase in crime rate. Nevertheless, this argument is still not solid enough because we can find this positive effect of secondary education even on less skillful (or possibly 'not much knowledge required') crimes such as violence.

Secondly, from the macroeconomic point of view, high GDP per capita perhaps indicates high benefits from illegal activities. It gives enough incentives to take risks, and the economic crime rates therefore increases. In addition, high employment rate implies a good labor market condition and better economy, which decreases the needs to earn money illegally, and thus there is a negative

influence of employment rate on economic crimes. However, we should notice that even though a good economic performance reduces people's pursuit of wealth, there are still significantly positive effects of GDP per capita and employment rate shown on immoral crimes. Beside the variables mentioned above, the clearance rate (used as the proxy of police efficiency) also presents its significant impact on entire crime, and more specifically on crimes against property. This is consistent with our speculation, even though not shown in all types of crimes. In order to decrease the occurrence of crime, the quality of police is also one of the main issues we can and we should make efforts to work on.

Lastly, some demographic factors play significant roles in crime as well. The regression result indicates that higher male-to-population ratio may is associated with low rates of overall crime, property crime and economic crime. Moreover, the proportion of population aged 30 to 59 and aged above 60 can influence most of criminal offences positively except for the insignificant result in violent crimes. All demographic variables mentioned above present different outcomes in contrary to our conjectures. Unfortunately, we need more complete social and criminal analysis to have deeper discussion of its causes.

To conclude, our findings suggest that:

- Higher attainment rate of secondary education with A-level exam unfortunately does not help to lower crime rate, but increases the occurrence of overall crime. Moreover, the secondary education (both with and without A-level exam) lead to higher rates of violent and property crimes. Higher tertiary education attainment ratio does not increase economic crimes as

expectation either; conversely, it is found to have a preventive effect on economic crime.

- As our assumption, higher GDP per capita leads to higher rate of economic crime and crime against human dignity.
- Even though the employment rate does not show significant influence on crime against property, its negative effect on economic crime is presented in the outcomes, while it is also found to have positive effect on immoral crime rate.
- Higher police efficiency (or higher crime clearance rate in the thesis) lowers the rates of overall crime and property crime.
- Lower male ratio to population is surprisingly found to increase total crime significantly, as well as property crime and economic crime.
- Unexpectedly, Population density does not show any significant influence on criminal activities.
- There is no significant effect of the ratio of population aged 15 to 29 on crime rate shown in the regression result. However, the outcome indicates that higher proportion of people aged 30-59 is associated with higher crime rates and property crime rates and the ratio of population over 60 years old shows a positive effect on criminal activities against property and human dignity.

The thesis takes a first step in investigating the relationship between education and crime. Owing to unavailability of data, as well as the dark figures of crime, inevitably there are estimation biases caused by omitted factors and unreported data in our analysis. The problem of dark figure is always a main issue and needs to be solved by the government sooner. Moreover, if the data accessibility gets improved, we suggest to add missing important variables such

as wage level and social inequality index, which have been proved to have significant influence on crime in empirical papers, in the future analysis to obtain more complete information. In addition to these factors, the criminal data of repeated offender ratio may be another influential variable, and it is worth trying to include this factor as well. We also propose the possible studies on individual level, as in many researches from the United States. The education data of each criminal, for example, can be quite valuable if it is available in the Czech Republic. Last but not least, we hope our research and ideas can help the topic of education and crime gain more attention and concerns of public, and benefit the whole society in the Czech Republic.

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